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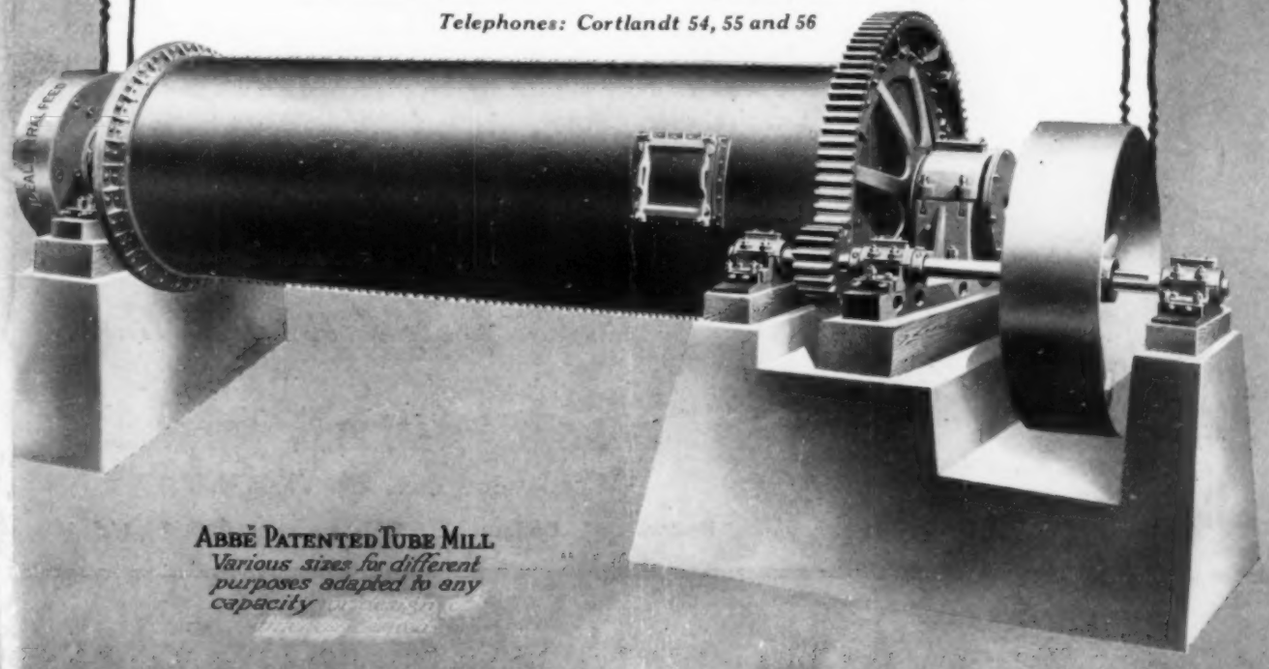

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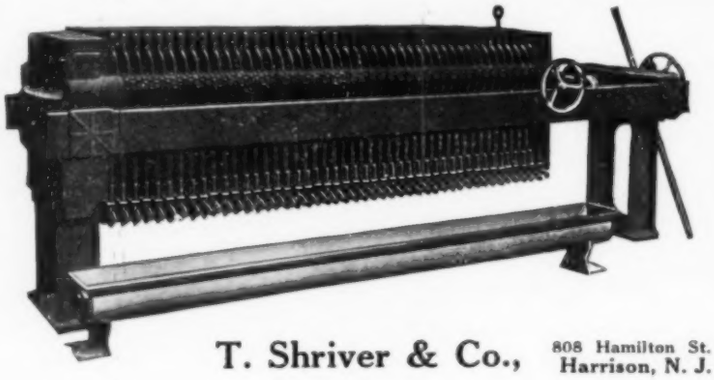

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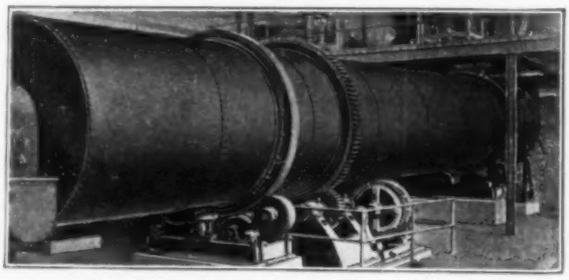

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Optimists in Spite of Appearances

IT WOULD not be difficult even for an optimist to indulge in lugubrious feelings by retrospect on the year that is ending. Hailed with delight because hostilities in Europe had ceased and peace was in prospect, Nineteen Hundred and Nineteen has been a distinct disappointment in many respects, and few, probably, will mark its passing with regret. Industrial strikes during the year were numbered literally by the hundred, and the man who has not suffered inconvenience more or less acute by reason thereof must indeed be an individual of small consequence or one having slight contact with the world of affairs. In fact, turmoil and unrest have been so marked and have so directly affected the daily life of the people that cynical commentators have been led to contrast the serene period of the war with the stormy aftermath of the Armistice.

Consideration of the Treaty, abortive in its results due to the rôle played by partisan politics, has prevented Congress from giving needful attention to legislation on water-power development and tariff regulation on such commodities as dyes, potash, optical and chemical glass, porcelain and certain metals and minerals. All data essential to the information of Congress on these subjects have long since been presented by the Tariff Commission and representatives of the industries, and committee reports have been prepared as a result of extended hearings.

But if the year's events afford occasion for dissatisfaction, we still believe that

> Sweet are the uses of adversity,
> Which, like the toad, ugly and venomous,
> Wears yet a precious jewel in its head.

If our own experience with arbitrary and unreasonable strikes, called and directed by irresponsible leaders, points a moral, and if the reaction of our subscribers and advertisers can be taken as typical of public sentiment toward such actions, we are constrained to believe that the strike has lost much of its force as a weapon of offense for Labor. If this be true, we will indeed have discovered a "precious jewel" which Labor itself may yet come to admire. And this is said in all sincerity and with cordial interest in the just deserts of Labor, for it has always seemed to us incongruous in the extreme that the most effective weapon thus far developed by Labor—the strike—should react against its intended beneficiaries, often with fatal force. We are confident that the future will develop new and more effective, as well as peaceful, means for preserving industrial peace and averting the deplorable deadlocks that have characterized the past year. A good omen in that respect is the preliminary report of the President's new Industrial Conference, which we shall discuss later.

Applied Economics

IT IS good advice that the people should be taught economics. It would be well if, instead of our being a nation of economic illiterates, we all knew at least the rudiments. But it is easier to say "teach economics" than to do it, and it does not follow, moreover, that if the people were taught economics they would act in the light thereof.

As to our domestic affairs, the thing desired is that men should be brought to a realization that we cannot have goods without producing them, that no large number of men can hope to profit at the expense of other men, by producing less than they should and getting higher wages than they are entitled to. Suppose every man and every youth were taught the principles of economics, what would be the value except in the application? What would move the individual to act upon the knowledge and alter his conduct?

Applied economics is what is needed, but it is rather difficult to expect much good to come from the individual applying his knowledge of economics once gained. There is a fine opportunity, however, for economic studies to be made and the results or findings to be placed before the public. A great deal of work is now done in the collection of statistics of prices of commodities, whereby the public is given information relating to the cost of living. While it may be of interest to know that in a given period the average price of commodities, or the cost of living, has increased or decreased by a certain percentage, yet it would be much more useful if information were secured as to why the change had occurred. It may be helpful in settling a labor dispute to cite facts as to what it costs the workman to live, but labor disputes frequently arise because the workman is not producing as much as the laws of economics would dictate. Instead of thinking only of what the workman ought to be able to buy with his wages, it would be well to think also of what services he proposes to render for those wages.

This continued dealing in averages, of commodity prices and wage rates, tends to becloud the situation instead of throwing light upon the way out. The public should be informed of specific facts. For instance, coal miners do not work full time. That is economically improper, yet recently the coal miners demanded a 60 per cent increase in their rate for mining a ton of coal, on the very ground that they work less than 200 days in the year.

Individual industries could study their economic results to advantage and those that can make a good showing would find it advantageous to make the facts public. Those that cannot should seek to improve their condition. At present it is easy to show at least one wide

divergence in price relations. Thus: Bradstreet's index number of all commodities now stands at 125 per cent above its ten-year pre-war average 1904 to 1913 inclusive. The finished steel prices promulgated March 21, which the United States Steel Corporation has taken the lead in adhering to despite requirements in excess of the supply, are up only 81 per cent. The steel industry does not show this low percentage through having been backward in advancing wages, but rather because the bulk of their men must follow the machinery and therefore have not decreased as much in efficiency as has been the case in some other industries.

Those industries that have exerted the strongest influence in pulling up the index number should be studied to see what is wrong with them.

Fuel Oil Combustion And Conflagration

FOR some time the various municipal authorities throughout the country have been studying the question of legal regulations governing the storage and use of fuel oil. That some kind of rules will shortly be adopted is certain, but whether they will be practical or not will largely depend on the experience and motive of the drafters. Of course if the result desired is an absolute prevention of fuel oil conflagrations, rules can be made with a margin of safety as wide as the ocean. In this case the high cost of engineering and equipment would soon offset any advantages in burning oil as fuel. This would please the city fire chiefs, because most of them are mainly concerned with extinguishing fires and naturally lend their testimony in support of rules which will entirely eliminate oil conflagrations regardless of other important considerations.

The rules as finally adopted should not be influenced by extremists on either side of the question. Men equipped with a far-reaching view of the broad economics of both fuels and fire hazards should assert themselves. There are these among the consumers and producers. The latter, being effectively organized in the American Petroleum Institute, are acting concertedly. It is for the attention especially of the former that we have included a discussion of a tentative draft of regulations in this issue.

Shape of Metallic Crystalline Grains

ON ANOTHER page is printed a portion of Dr. DESCH'S second report on the solidification of metals, in which he discusses some evidence bearing upon QUINCKE'S hypothesis, that immediately before solidification a liquid expels a small amount of immiscible fluid which arranges itself in cell walls, within which solidification of the main mass proceeds. A marked similarity between foam cells and crystals of β-brass disintegrated by mercury is actually found, but crystalline grains of other metals could not be isolated in sufficient number to yield useful data.

While a study of crystalline boundaries developed in a micro-section gives little light upon their spatial dimensions, one cannot help feel that photographs of a succession of parallel sections could be used to build up crystal shapes much as a relief map is constructed from contour lines. Thus, a small block of metal might be placed in a fixture so that successive surfaces could be ground exactly parallel to each other, and a closely referenced area successively photographed at uniform magnification. The thickness of metal removed might be determined by caliper or balance and each micrograph mounted on a sheet of wood of corresponding thickness. This could then be cut apart along the crystal boundaries, and each section glued in correct orientation and position to the corresponding ones from the preceding photographs. A tedious job, but well within the skill of many model makers.

Such solid forms, capable of reproduction, would be of great value in an investigation like this, and would at the same time check various ideas regarding the relation between grain size and counts from a micrograph.

One reservation must always be borne in mind when trying to determine the mechanism of solidification by the use of such crystalline studies, and that is the obvious fact that the history of the metal subsequent to its solidification has a profound influence on the eventual grain shape. It may very well be that the cellular structure of freshly solidified metal is unstable at lower temperatures, and the heat residing in the ingot during cooling is sufficient to modify profoundly its constitution. The efficacy of drastic quenching may not be doubted in some cases, although in others it does not prevent an astounding amount of molecular migration.

A successful conclusion is to be wished for Dr. DESCH'S most difficult problem. It will doubtless yield immense immediate light into the structure of pure metals; it may clear up perplexing and expensive troubles with impurities in melts. But as is usual with that dubbed "pure research," the eventual effect of a clear insight into the mechanism of solidification cannot now be dreamed.

The Forest Products Laboratory Valued Servant of the Industries

GOVERNMENT institutions are akin to business firms in that they have individuality, determined largely by the economic benefit each renders to the population served. If a commercial project is not based on the principles of real assistance to the community, it fails, but on the contrary, as the service becomes of increasing value, the firm prospers in fulfillment of the owner's expectations.

A government organization backed with initial appropriations can, within a comparatively short time, procure results much needed for the public welfare, thus immediately taking its place among recognized institutions.

Then appears a marked difference in the progress of the two, for the business organization receives return directly and almost in proportion to value given, while the government body, the public itself serving the public, enjoys no immediate return to the unit performing. It must needs wait until through general appropriation, involving the long process required to remove money from one pocket to the other, the necessary funds are made available to the institution. The full growth of the deserving government organization is thus frequently hampered in periods of rapid development.

Sharply and distinctly outlined against the background of lethargic governmental departments, standing to the fore in largeness of service and economic return to business industrial, is the Forest Products Laboratory. Published elsewhere in the pages of CHEMICAL & METALLURGICAL ENGINEERING, an article under the title "The Forest Products Laboratory" re-

counts in detail some of the things accomplished by this institution. In no less proportion than the ensemble of the industries of the United States, the chemical and chemically controlled industries are benefited by the activities of the Laboratory.

The Laboratory is supported by Federal appropriation amounting to $175,260 annually, for the year beginning July 1, 1919, which is no greater than the pre-war figure. During the war its activities were greatly increased and supported by additional allotments from the War and Navy Departments. These have been largely withdrawn, leaving the organization dependent on the funds inadequate to support the natural growth—inadequate because of the depreciation of the buying power of the dollar—and especially insufficient to cover the necessary research in adaptation of valuable war-time discoveries to peace-time production.

A committee composed of representatives from a number of national associations, covering the industries most vitally interested in the service rendered by the Laboratory, after careful investigation, hold the opinion that an annual appropriation of not less than $500,000 should be made by Congress. The committee further finds that this amount could not be safely reduced without great loss to the public, the ultimate beneficiary of the Laboratory's output.

The cause is worthy, the need for adequate appropriation for housing and maintenance is immediate, and it only remains for the individuals at interest, namely, the whole public, to push the wheels through Congressional representatives. We are glad to lend our support to the movement and urge all engineering and scientific organizations to do likewise.

The Future of Commodity And Property Values

THUS far there has been little trend toward the correction of the anomaly left by the inflation the war caused, of commodity values, in dollars, being increased much more than values of fixed property by comparison with values before the war. It costs about twice as much to build a dwelling house as it did two or three years ago, and perhaps three times as much as 20 years ago, by reason of materials costing more, labor costing much more per day, and labor doing much less work in a day, but on the other hand the houses already built have not increased in market value in any such ratio. Inasmuch as houses have to be built as the population increases and old houses wear out, one would suppose that the value of the old house and the cost of producing a new house would tend to come together.

As to land values the case is different. Land is not produced, but the owner of land expects revenue and he would like to have his revenue buy him as much in commodities or labor as it did before the inflation occurred.

There is to be a resolution of forces, of course, according to immutable laws, but one does not know precisely what the laws are or what are the relative amounts of the forces or their angles.

There are many who argue that the decreased value of the dollar is simply a permanent thing, and all values that are expressed in dollars must be correspondingly increased, if they have not already been increased. The application of the theory, however, encounters difficulties of various descriptions and degrees. There are high school teachers who complain that they are receiving less wages than street sweepers. Possibly that situation can be remedied, but there are many billions of bonds whose holders can of course obtain no relief. Holders of stock may be given relief by dividend rates being increased, or by stock dividends being declared in case the Supreme Court decides that stock dividends are not taxable as income. There is no disposition to double freight and passenger rates, the increases that have occurred being regarded as relatively heavy as it is.

There is always a way to get around things, however, if it is absolutely necessary to get around. In a given industry, for instance, wages advance by an amount out of proportion to the general alignment of affairs, and then the introduction of labor-saving machinery is encouraged, whereby eventually the labor cost of production is brought to a lower level than ever.

There are some restraining influences to the increase in value, measured in dollars, of fixed property. For the purpose of the present argument it does not matter what the influences are. The cost of duplication being greatly advanced, increases in the number of dwelling houses, of power plants and other kinds of property are somewhat discouraged. Correspondingly, there is a greater incentive to secure efficiency from such property as exists or is to be built. More families can be accommodated in apartment houses, with the same capital, than by building separate dwellings. By better design and better machinery power plants can be made more productive.

In other words, efficiency will make greater strides in some quarters than in others. As a rule improvements are forced rather than spontaneous, and where there is the most pressure there the greatest progress will occur. The public service corporation, that cannot double the book value of its property, its charges and its dividend rate, must make its property more efficient.

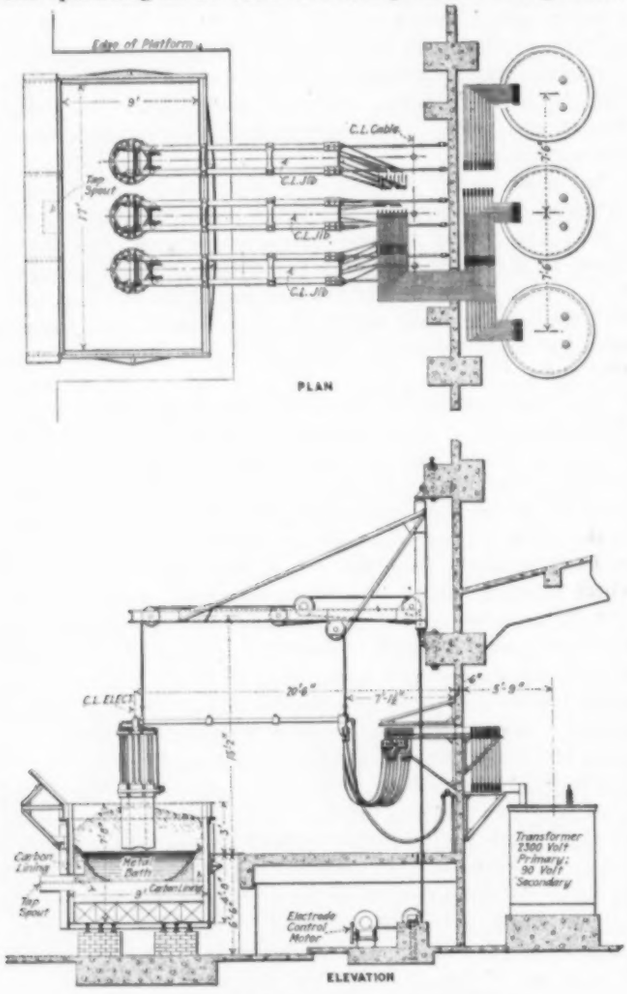
One must remember that the affairs of men are produced by men. It is what is in men's minds. Some theorists would have it that if the amount of the circulating medium is increased by a certain percentage, then all prices will automatically advance by a certain percentage. There is nothing automatic about it. A suggestion along this line is furnished by the New York stock market, which is held to represent actual values, but those wise in Stock Exchange doings assert that "stocks never advance; they are put up." In other words, the shares may be entitled to bring higher prices but they do not bring the higher prices without assistance. Price advances in the commodities that are bought by the general public occur largely according to the mental attitude of buyer and seller. If the seller is courageous and the buyer careless the price advances. If the buyer really cannot afford to pay the advanced price, or curtails his consumption, the price is likely to fall. It would be marvelous indeed for the people to get along at all if all their complaints about "the high cost of living" are really true. The individual complains of the advance in the unit price but says nothing about his ability to get along quite comfortably with a smaller number of units. Eventually there will be found room for commodity prices to come down somewhat, though probably not in this period of strikes, restricted production and general carelessness in spending. Property values, on their part, will probably advance somewhat, and a few years hence commodity and property values will probably be found to be in somewhat the same relation as before the war.

Western Chemical and Metallurgical Field

Silicomanganese Furnace Production Record

SILICOMANGANESE was produced in this country as a result of the war demand for steel deoxidizers. It has the advantage over ferromanganese in that it can be easily produced with a low carbon content and from manganese ores high in silica. Although not used in this country to any large extent, silicomanganese has been very favorably considered and used in quantities in England, France, Russia, the Scandinavian countries and Germany; in the latter country very extensively during the war. It is considered to be a more active deoxidizer than either ferromanganese or ferrosilicon alone.

A furnace was designed and erected by the Beckman & Linden Engineering Corporation of San Francisco during the spring of 1918. The furnace is of the open-top design, rectangular in plan, 9x17 ft. outside dimensions; of 3000-kw. capacity, using 60-cycle, 3-phase current operating at 90 volts between phases. The general



3000-KW. SILICOMANGANESE FURNACE

design is shown in the accompanying drawing, with dimensions, showing a side elevation and a plan view. The electrodes are hexagonal in shape, 20 in. in diam., this form being chosen as giving better contact between holder and electrode. The flexible conductors from the closed delta are connected to a copper pipe conductor; the electrode, electrode holder and conductors are supported from an overhead jib. The cooling water for the holders flows through the copper conductor pipe. The furnace is tapped by burning through the refractory plug and solidified metal at the tap hole with a graphite rod which is electrically connected to one phase during this operation. Charging is done by hand from the platform, the furnace being of sufficient height above the platform to protect workmen from excessive heat.

The table gives the consumption of raw materials, electrodes and power for the first fifteen days of August, 1918. Average weight of electrodes 1180 lb. Average analysis of manganese ore charged was 39.5 per cent Mn, 23 per cent SiO_2. The Segundo coke from Colorado, which was used during the test, averaged 14 per cent ash. The entire charge was melted to alloy, no slag being formed. The manganese recovery averaged 93.6 per cent, the loss being caused principally through volatilization.

CONSUMPTION OF RAW MATERIALS, ELECTRODES AND POWER

Date, 1918, Aug.	Silicomanganese Production Lb.	Per cent Mn. in Product	Mn Ore, Lb.	Silica, Lb.	Coke, Lb.	Scrap Steel, Lb.	Electrodes, No. Used, 20 In. Diameter	Power, Kw.-Hr.
1	25,592	53.75	38,600	7,050	17,250	6,345	2	66,200
2	26,894	54.5	36,800	6,900	17,625	6,210	1	66,600
3	25,078	53.25	34,500	6,900	15,750	6,210	2	60,600
4	25,876	54.0	37,500	7,500	16,100	6,750	1	66,500
5	26,940	52.75	37,500	7,500	17,280	6,750	2	68,860
6	23,794	53.0	32,300	6,180	14,970	6,075	2	60,970
7	23,242	53.5	30,000	5,565	11,575	5,835	2	65,290
8	25,080	53.75	36,750	6,860	16,430	7,100	..	67,230
9	20,621	52.25	33,750	6,300	12,350	6,530	1	64,030
10	17,239	53.75	26,250	4,900	9,500	5,075	1	40,220
11	27,053	53.5	37,500	6,720	15,930	6,960	2	57,290
12	22,931	52.75	38,400	6,720	14,985	6,960	1	61,960
13	28,190	53.0	40,000	7,000	17,030	7,250	..	63,850
14	17,837	53.0	27,200	4,760	11,900	4,930	2	58,100
15	22,401	53.0	31,100	4,702	14,050	5,622	1	56,750
	358,768	53.3	518,150	95,557	222,725	94,602	20	924,450
Aver. per 24 hr.,	23,918	53.3	34,534	6,370	14,848	6,307	1¼	61,630
Aver. per 2240 lb.,	.....	.....	3,235	596	1,403	591	147 lb.	5,770

Average analysis of silicomanganese produced: Mn, 53.30 per cent; Si, 23.12 per cent; Fe, 23.00 per cent; C, 0.40 per cent; P, 0.18 per cent.

Alaska's Mineral Production

Regular mining in Alaska may be said to have been begun in 1880 when the Juneau gold placers were first exploited. Since that time the value of the mineral wealth produced has been estimated at more than $418,000,000. During 1918 the mineral production was valued at $28,254,000, which is less than that for 1917 by $12,500,000. This decrease was chiefly in copper, which fell from 88,783,400 lb. valued at $24,240,598 in 1917 to 69,224,951 lb. valued at $17,098,563 in 1918, the reduced output being due to the shortage of labor and ships. There was also a reduction of the output of gold, silver, lead, tin and tungsten due to scarcity of labor and the high cost of supplies. The production of antimony practically ceased because of the inability of the producers to compete with the cheaper foreign product. The production of coal, however, increased from 53,955 tons valued at $265,317 in 1917 to 75,606 tons valued at $411,850 in 1918. The production of platinum, which began in 1916, continued on an increasing scale.

According to current reports from the U. S. Geological Survey, twenty-eight gold dredges produced $1,450,000 worth of gold from 2,490,000 cu.yd. of gravel. In 1917, 36 dredges handled 3,700,000 cu.yd. of gravel and recovered gold worth $2,500,000. The total value of the gold produced by dredges to the end of 1918 is es-

timated to be $19,035,000. The value of the placer gold produced in 1918 was about $5,900,000, compared with $9,810,000 in 1917. The output of platinum, palladium and other metals of the platinum group for 1918 is estimated at 284 fine ounces valued at $36,600. Substantial amounts of palladium and some platinum are recovered from the copper ore of the Salt Chuck Mine, near Ketchikan.

The tin mines of Alaska produced 136,000 lb. of metal valued at $118,000 during 1918, a decrease of 64,000 lb. from 1917. During the year only one dredge was operated. A recent discovery of placer tin has been reported from Potato and Humboldt creeks, on the Seward Peninsula, and from Moran Creek, a tributary of Melozi River, where gravels are said to contain 2½ lb. of tin and 10c. worth of gold to the cubic yard.

The Alloys Research Association

THE Division of Industrial Research of the National Research Council, after a careful canvass of the situation and the many problems which merit immediate attention, has decided that perhaps the greatest number could be served by the formation of a co-operative association to engage in fundamental research in alloys. The Division fully recognizes the fact that a great deal of exceedingly valuable work has already been done in the alloy field, but it is also convinced that progress in many lines of manufacturing is arrested because of the lack of certain facts which are fundamental and that the solution of a number of manufacturing problems depends upon additional information which can only be obtained by intensive research.

The Division believes that these problems are so broad that no single organization or laboratory can profitably do the work as thoroughly as it needs to be done, and that the most satisfactory method is for the industry to undertake the work under its own control and at its own expense. The whole question has been discussed thoroughly by the Division itself, most of whose members are men with commercial experience and connection, and the provisional outline submitted below has been formulated with the co-operation of those men who are most familiar with conditions in the alloy field and who are themselves very closely identified with the remarkable progress which has thus far been made. These specialists represent both the users of alloys and those whose primary business it is to manufacture alloys for sale as raw materials.

The Division has been encouraged in its work by the excellent records made in those industries which have supported research on some co-operative plan, notably, the National Canners Association and the Malleable Iron Manufacturers. In addition, a number of fellowships have been supported by associations and manufacturers in special fields with successful results and a substantial profit to themselves. It has been demonstrated that the most progressive concerns, which are commonly supposed to require no further assistance in research, frequently derive the greatest benefit due to their ability to apply the results of the association to better advantage in their own works.

This new organization, which will be known as the Alloys Research Association, will undertake systematic research into fundamental questions affecting pure metals and alloys, both ferrous and non-ferrous. An information service will be maintained to supply members with summaries of technical information in the metal field, answer inquiries and assist the research workers by preparing monographs on each phase of a proposed research, analyzing and recording results of research, and editing material for publication.

The membership of the association will include individuals, institutes and other associations interested in the production and use of alloys as raw materials in manufacturing processes. Initially, each individual member will pay $1000 annually for a minimum period of five years, while an institute will be assessed a larger sum, depending upon the extent of its membership and the importance of alloys to it. Upon recommendation of the Executive Board, problems of general interest will be studied at the expense of the association and the results made available to all members. A member may also have undertaken a problem in which he alone is interested, at cost, for his sole benefit.

Undoubtedly a special laboratory will sooner or later be required, but until the results of the work warrant it, it is proposed that existing laboratories be used whenever possible.

Every effort will be made to avoid duplication between the work of the association and that of other agencies in the field. Through the services of the Advisory Committee on Alloys Research, of which Mr. W. M. Corse is chairman, it will be possible to keep in touch with work now in progress or contemplated and the activities of the association be so guided as to co-operate with such work.

The proposed articles of association, which have been briefly summarized here, are set forth as tentative and provisional, for the purpose of inviting discussion and constructive criticism. Those interested are urged to contribute their views to the vice-chairman of the Division, addressing H. E. Howe, National Research Council, 1201 Sixteenth Street, Washington, D. C., at their early convenience.

The Robert W. Hunt Award

Capt. Robert W. Hunt has placed in trust in a Chicago bank the sum of $5000 to establish payment of what is to be known as the Robert W. Hunt Award, $250 of which will be paid each year for the best paper contributed to the *Proceedings* of the Western Society of Engineers on any subject pertaining to the manufacture or treatment of iron or steel products. The purpose of this award is, in the main, to make membership in the Western Society of Engineers attractive and useful to the younger men of the profession.

The conditions in general which surround the award of this sum are that the member must not be over 30 years of age or a member of the faculty of an educational institution. The decision of the award shall be given to a committee of three, said committee to be annually appointed by the president of the Western Society of Engineers. One member of this committee shall be a man of recognized experience and established reputation in the manufacture of iron or steel. If in order to obtain such a member for the committee it is necessary for the president to go outside of the membership of the Western Society of Engineers, he shall be authorized to do so.

If in the opinion of those upon whom the allotment shall rest there should not have been contributed during the year any paper worthy of the award, the trust company shall pay the year's interest to the proper authorities of St. Luke's Hospital.

An Innovation in Insurance for Chemical Plants

EXPANSION in chemistry is coming into view on every side. The latest addition is the establishment of a department of chemical risks by four associated fire insurance companies, namely, the North British and Mercantile Insurance Co. of New York, the Pennsylvania Fire Insurance Co. of Philadelphia, the Commonwealth Insurance Co. of New York and the Mercantile Insurance Co. of America, also of New York.

For many years it has been the custom among fire underwriters to classify "chemical works" as a group by themselves, and to consider them as abounding in unknown and incalculable hazards, and to write very modest lines of insurance upon them. In view of its status as a key industry and of the economic need of chemical manufacturers for indemnity in the event of loss, the above-mentioned insurance companies appointed W. D. Grier to look into the subject generally, to see how much business there was, and if it would be worth while to establish a special underwriting department to extend service to chemical industries, such as is given to manufacturing concerns under sprinkler protection, with a constant view to decreasing the fire hazards.

The investigation showed a great deal to be done, and these companies organized a special Chemical Department, Mr. Grier being put in charge. It is believed that they are the first to organize such a department, the object of which is to give fire protection engineering service to chemical industries, looking to elimination of unnecessary risks and consequent loss and interruption of manufacture. This is done without charge to parties assured.

Mr. Grier's investigations brought out some of the defects in installation which are found more or less frequently. Among them are the following:

In regard to such inflammable liquids as benzene, etc., the method of storing is always a matter of interest, and so also is the installation of piping, with the risk of a break in the connections and a resulting fire that is mean to handle.

Arrangements for warming tank cars are often defective and dangerous.

There are frequently found defective fuel oil systems and these cause fires.

Apparatus provided with direct heat often have defective furnaces.

Oil baths are often improperly installed and carry considerable risk.

Nitration may be inadequately isolated and defective methods of nitration are occasionally discovered.

The methods of handling highly inflammable or explosive substances need careful study in each case, and the same may be said of the care of intermediates that are of an impermanent nature.

A frequent source of trouble is the defective venting of inflammable fumes.

Many grinding processes involve serious fire hazards.

The storage of finished products should not be in proximity to the hazard of fire by contagion. This would seem to be self-evident, but it is often forgotten, and the greatest risks and the greatest values are often found together. Sometimes a little flash will open a lot of sprinkler heads and wet down goods of large value. This makes a difference between no claim at all, or possibly $25 or $50 on the one hand, and $40,000 or $50,000 on the other.

Service parts such as washrooms, toilets, baths, clothes lockers, etc., are often the starting place of fires.

Electric wiring systems suffer deterioration from acid or other fumes, and fires result from cross circuits.

In other words, there is an insurance engineering angle of attack that is often otherwise overlooked, and it is the effort of Mr. Grier and his associates to overcome this neglect. Sometimes the best method of meeting the situation is by making the buildings, as in a powder mill, small and scattered, and to provide heavy outside protection to keep the fires confined to a single unit in each case.

The laboratories of the National Board of Fire Underwriters at Chicago have been doing excellent work in this connection for many years, but the managements of these companies are to be congratulated on their progressive spirit. Once upon a time there was stored in Liverpool, as recollection serves, a large quantity of cotton in the ground floor of a warehouse, and a large quantity of nitrate of soda on the floor above, under the roof. The roof leaked, and the merchandise remained in storage a long time. The fire that ensued was a surprise. There are some fire underwriters who would still be surprised at it.

Brass Founding Methods in Germany

Recently a deputation of men connected with the British Brassfounders Association visited German works in the Rhineland, and, according to the *Iron and Coal Trades Review*, have reported that the main advantage the German has is in the smaller variety of articles produced by each manufacturer, namely, greater concentration on output, resulting, of course, in a larger turnover, combined with that careful attention to the details of manufacture which is a characteristic of the German, from the head to the humblest employee.

The casting methods appear to offer the greatest divergence from the English system, and while both hand and machine molding appears to be employed very generally, the following differences may be particularly noticed: It appears to be the common practice in all brass foundries to put the molds in an oven as soon as they are made and leave them there until the next day, such molds being taken from the oven the next morning and poured during the day and the oven again refilled for drying a new lot the following night.

Both pit furnaces and tilting furnaces are used for melting, several bessemer-type tilting furnaces made of iron and lined with brick being noticed, this system avoiding the use of crucibles except as a medium for carrying the metal from the furnace to the molds; in some cases the ladles are of iron. The molds when cored up are placed on top of each other into a pile three or four feet high, and the whole bolted together, after which they are laid on end for pouring in the usual way. It also seems a common practice for the castings to be cut off the runners when cold by means of a sprue cutting machine. In one works where hand molding was in progress, in place of using mallets a heavy metal ball about 7 in. in diameter and weighing nearly 50 lb. was rolled all over the mold in order to compress the sand, and this method would possibly insure more regular pressure for work which does not vary too considerably in height. It was also noticed in several instances that loose locating pegs were inserted in the sand of the mold to assist in the accuracy with which the molds were matched.

The Whole U. S. Patent System in Danger

WHEN the Government Printing Office sets up and prints everything that a Senator or Congressman says when he is talking against time to defeat a desirable bill which will pass if his wind gives out, for the merit of which his own party cannot get the credit, it does seem to be about the most useless typographical establishment in the world. But occasionally its publications are of lively interest, and of these we commend a book entitled "Hearings Before the House of Representatives of the 66th Congress, First Session, on H.R. 5011, H.R. 5012 and H.R. 7010. It covers 320 pages, and every bit of it is interesting.

The system of granting an inventor a 17-yr. monopoly for his invention for a comparatively small fee originated in the United States, and its immediate effects were good. These were not measured by the prosperity of the inventors; they were made manifest in the greatly increased number of useful inventions which were recorded in response to the encouragement provided by the system. This was so marked that all the progressive countries of Europe, save those of Latin origin, adopted methods similar to those of this country. The peculiarity of these methods consists in a careful examination of each invention, more particularly as to its novelty, before the patent right is granted. In Latin countries but little more than a system of registration is in effect. Anybody may register what he claims to be an invention by paying the fee, and then he must establish his rights afterward, if he can. This so-called French method has not been found to work well in regard to real inventions.

Switzerland and Holland tested out the plan of having no patents at all. Both found that without a patent law the incentive to follow up and manufacture new things was lacking, and that progress in this respect declined rather than increased. Later both countries enacted patent laws based on the system in force in America.

The Merit of Patents

The merit of patents seems to be due to several related causes. To introduce anything new usually requires time, energy and expense, in which time and energy may also be expressed in terms of expense. Without a monopoly for a given time the inventor or owner of the patent must nevertheless undertake or provide for the cost of introduction, after which any competitor may reap the same benefit as he. Without a patent the inventor is at a disadvantage, because any competitor can reap his reward without paying the price of introduction for it. The premium on novelties takes a precipitous dip as soon as we pass the millinery business, and it becomes a charge as soon as we reach materials and machinery. The lack of a patent system makes invention a liability rather than an asset. On the other hand, when an inventor publishes his invention in a patent he becomes the nation's teacher; he stimulates enterprise and encourages more invention. Fundamental patents are always followed by a large number of applications from new sources relating to improvements in detail. And we must remember that after an invention has been a monopoly for 17 years it becomes the property of the people.

What our Patent Office suffers from is neglect—Congressional neglect. We shall endeavor to show its most pressing requirements.

As soon as the National Research Council found itself it appointed a committee to consider the matter of patents. These gentlemen were William F. Durand, chairman; L. H. Baekeland, acting chairman in Dr. Durand's absence; M. F. Pupin, R. A. Milliken, S. W. Stratton, Reid Hunt, F. P. Fish, ex-Commissioner Thomas Ewing, and Edward J. Prindle. They proposed the three bills under discussion, which are now in the hands of the Committee on Patents. We shall consider their provisions after we have discussed the situation.

Shabby Treatment of Patent Examiners

In our issue of Sept. 1 we spoke editorially of "Shabby Treatment of Patent Examiners." In 1848 the salary of each primary or chief examiner was fixed at $2500, or the same as that of members of Congress. It was held that as the examiners must be men of professional education and training, their habits of life and requirements would be about the same of those of Congressmen. Their responsibilities are very great; a single error may involve millions of dollars in expense, and do incalculable injustice. The cost of dishonesty would also be beyond computation. The salary of these same primary examiners is now $2700. Since 1848, Congressmen have raised their own salaries from $2500 to $7500, and those of principal examiners from $2500 to $2700. There are 45 primary examiners, and 360 first, second, third and fourth assistant examiners receiving respectively $2400, $2100, $1800 and $1500 each per year. The force includes 7 doctors of philosophy, 18 doctors of medicine, 1 doctor of dental surgery, 21 mechanical engineers, 19 electrical engineers, 19 civil engineers, 2 chemical engineers and hundreds having masters' and bachelors' degrees. Few good examiners will remain at these figures, except those that are staying on out of loyalty and love of the work. The Commissioner is required to fill vacancies with temporary appointees, because the Civil Service Commission cannot induce enough good men to try for the positions. So much for salaries. The work is rapidly running behind, and it is falling off in quality. Nevertheless this same corps of examiners is the very key to our entire patent system. Every neglect, every mistake on an important invention invites long, expensive litigation and hinders a poor inventor from obtaining his rights.

Anomalous Position of the Patent Office

The Bureau is in charge of the Secretary of the Interior, although it can hardly be said to be under his authority. He represents it, but he does not control it. His approval is required for changes in the rules of practice, but he has no power to compel changes, or to organize improvements. There is nothing in common between the interests of the Interior Department and the Patent Office. Its situation is in the Interior Department, but not of it. The result is the Patent Office is either left out in the cold, or its needs are judged in connection with the requirements, for instance, of the Pension and General Land Office—and this through no fault of the Secretary of the Interior either. The Congressional Mind builds up its own theories.

In regard to patent litigation we have this situation: The calendar of the Supreme Court is so crowded that no patent suits will be considered by it, save in very rare instances. The right of appeal except under a writ of certiorari which involves the willingness of the court to hear the case was taken away in 1891. The final courts of adjudication in patent cases, therefore, are in effect the nine United States Appellate Courts of concurrent jurisdiction. Therefore if either party to a patent suit is dissatisfied with the decision of one of the nine Circuit Courts of Appeal, he may try the suit out again in any one of the eight others, and thus keep up the misery for an insufferably long time. Let us quote from the address of Mr. Frederick P. Fish before the committee. He said: "If either the plaintiff or the defendant in a patent suit loses his case, he says to himself that the particular court in which his case was decided only controls the territory, for instance, of the First Circuit—Maine, New Hampshire, Massachusetts and Rhode Island—and that he may be able to get a different decision in a different part of the country. He has every inclination to try his luck in Ohio or New Jersey or somewhere else, and very frequently when the plaintiff is beaten he will go into another court in another section of the country, and try the case over again. In like manner infringers in other circuits will go on as before, hoping for a different result in a new case against them."

This is an exceedingly unwholesome condition of affairs. It also stands to reason that, with the best of intentions, some judges are quick to understand the points at issue in a patent suit, while others have difficulty in achieving a clear vision of the same problem.

Damages the Last Thing Expected

Under present conditions when a patent suit is decided and, let us say, infringement is proved to the satisfaction of the court, an injunction is issued. But damages may not be obtained save in very rare instances. Usually it is held that the exact amount of damages must be proved. It is seldom that a patent covers the whole of an article that is sold, so that the plaintiff must figure out and prove the exact sum involved—which of course he can't. And in default of precise figures the usual award is six cents. The law has ways of its own. Recently there have been two or three decisions in which the courts have taken a more liberal attitude and awarded a reasonable royalty, but it is admitted by lawyers that it will take a whole generation to induce the United States courts to adopt this position generally, unless special provision is made for it by legislation. As things are, about the last thing a plaintiff in a patent suit expects to get is damages.

The Legislation Proposed

The proposed legislation remedies all these features. It provides for a new court of seven members to sit in Washington. The Chief Justice is to be appointed for life by the President, thus giving to the court an element of continuity. The other judges are to be selected by the Chief Justice of the United States from the various District and Circuit Judges throughout the land, and are to serve for six years each, three to be appointed every three years. This would assure the appointment of judges who had experience in patent litigation, but their rotation in office would avoid the likelihood that the court become narrow in its views, owing to the nature of its work. It would also provide that the judges come from various communities, and thus the charge that any special interests might have had a hand in the appointment would be avoided. They are to be adequately paid, the Chief Justice at the rate of $12,000 a year, and the Associate Justices $11,500 each. The establishment of a Court of Patent Appeals has been advocated by the American Bar Association for many years. It would put backbone and dignity into our patent system.

Another bill increases the salaries of members of the Patent Office staff so that, for instance, principal examiners now getting $2700 will receive $4000, and the first, second, third and fourth assistants respectively $3300, $2700, $2200 and $1800 each. Other salaries are in proportion and are no more than commensurate with those paid in other and unforgotten departments of the Government. Other countries—Great Britain and Holland, as was brought out in the hearings—pay their examiners and staff much better than we do.

Another bill makes the office an independent bureau, and provides also that "If proof is not offered, or in the absence of adequate proof of the amount that should be awarded as damages or profits, the court, on due proceedings had, may adjudge and decree to the owner, payment of a reasonable royalty or other form of damages." In other words, it substitutes a reasonable royalty for six cents.

Every feature of these bills is of prime importance, and is of interest to the people as a whole. Under our present defective system it usually takes from six to eight years to find out whether an important patent is valid or not. Under the proposed changes, one and a half years should be the maximum time, save in extraordinary cases. Under present conditions, unless a man has vast wealth back of him he cannot afford patent litigation against a rich offender. That is a situation so radically wrong and so contrary to the temper of the times that it is not even the part of good citizenship to endure it.

People Should Awake to the Situation

Many persons refuse to take the trouble to read anything about patents on the ground that they are not interested. But that is a fault of neglect. It isn't so much that inventors need to be protected; it is an unfair situation that has come into being because of Congressional neglect that threatens the peace and general welfare. The present uncertainty and expense of maintaining a patent are very costly, and the money to pay for it in the end comes out of the pockets of the public—and swells the cost of living. Patent business is everybody's business for this reason, and because it encourages invention. Therefore we have no right to sit still and twirl our thumbs while one of our important and needed institutions goes to seed—and sows dragon's teeth in the process.

It is generally admitted by men of experience in Washington that the best way to reach the Congressional Mind is to write from a Congressman's district to him. If we can induce our readers to write to their representatives in Congress urging them to support the bills mentioned, H.R. 5011, H.R. 5012 and H.R. 7010, we believe we shall have contributed an important service.

The Forest Products Laboratory

A Government Institution Serving the Public Both Directly and Through Valuable Data Furnished to Engineers, Architects and Industrial Concerns—Research in Methods of Mechanical Application and Chemical Derivatives of Forest Growths

BY CHESTER H. JONES

THE Forest Service of the United States Department of Agriculture maintains the Forest Products Laboratory, located at Madison, Wisconsin, and operating on industrial research in all applications and uses for products of the forest. Funds for the support of this work are at present appropriated by the Department of Agriculture and the Army and Navy Ordnance and Air Services. The University of Wisconsin furnishes the buildings (Fig. 1), together with heat, light and power. The officials and operators are all on the Government payroll.

The facilities are at the service of any individual or firm that wishes to use them. Contact with the industries and public is continued through personal visits to Madison, correspondence, official publications, and articles appearing in the periodical press. The laboratory is open to visitors, both those who have a general interest and those who wish to spend some time in working out specific problems. Every effort is made to give full and complete answers to inquiries made by correspondence.

Any one may request that his name be placed upon the mailing list to receive future publications on special subjects as they are issued. The Superintendent of Documents, Government Printing Office, Washington, D. C., distributes "Price List 43, Forestry," which covers all publications of the laboratory. The bulletins are to be had free at Madison until the supply at hand has been exhausted. About once a month the laboratory issues mimeographed sheets called "Technical Notes." These are brief summaries of the recent work, written especially for the busy man who is interested in results.

IMPORTANCE OF FOREST RESEARCH

A great deal has been written in the technical and popular press about the importance of our forestry problems, and we have all been impressed in a general sort of way. In order really to appreciate the value of research in forest products to the industries dependent upon them and consequently to our universal welfare it is necessary only to witness the work in progress at the Madison laboratory. The visitor becomes impressed with the thought that there can scarcely be an individual Government organization whose work is of more worth to our commercial life.

In a recent article[1] reference is made to the subject in part as follows:

"With a total annual cut of 40,000,000,000 ft. board measure of merchantable lumber, another 70,000,000,000 ft. is wasted in the field and at the mill. In the yellow pine belt the values in rosin, turpentine, ethyl alcohol, pine oil, tar, charcoal, and paper stock lost in the waste are three or four times the value of the lumber produced. Enough yellow pine pulp-wood is consumed in burners or left to rot to make double the total tonnage of paper produced in the United States. Meanwhile, our paper-makers memorialize the community on the scarcity of paper stock, and pay $18 a cord for pulpwood which they might buy for $3 a cord."

With such quantities as this in mind it can easily be seen that each small finding of the laboratory may be great and far reaching in ultimate commercial result.

CO-OPERATIVE WORK

It is the policy of the Forest Service to obtain to as large an extent as practicable the co-operation of the wood-using industries most directly concerned with the subjects or problems under investigation. The exact terms of this co-operation are determined in each specific case. The investigation of a subject is generally not regarded as complete until results obtained experimentally are checked on a commercial scale to determine the industrial application. When this has been done, further co-operation covering the same ground is not entered into.

The laboratory will furnish such general advice and assistance to any one interested as are available in the files covering previous work, such as design, construction and operation of commercial plants for wood preservation, distillation, kiln drying, etc. In some cases approximate costs and suggested plans and specifications may be given. The laboratory may examine methods in existing plants and recommend improvements.

In cases of active co-operation, a remuneration to the Service is expected, equivalent to the total cost of the work done for the co-operator, including both time and expense of members of the laboratory organization detailed on the project. Such remuneration may be reduced by the extent to which the work is strictly experimental and of value to the Service rather than to the co-operator. When practically all the work proposed is investigative, the laboratory having little or no expert knowledge on the subject to begin with, and the results will be of value chiefly to the general public, the charge to the applicant may be comparatively low or eliminated altogether.

As far as practicable co-operative projects will be covered by written agreements. Such agreements are required whenever co-operative investigations of a specific character are to be continued over a period beyond six months or at a cost to the laboratory of over $100.

Reference to the chart (Fig. 2) will give a clear idea of the organization of the Service, and the type of research work done by the laboratory is shown under "Technical Industrial Research Problems." The views in Fig. 1 show the buildings employed to house the operations. The main building contains the general busi-

[1] "Developing the Estate," by Arthur D. Little, *Atlantic Monthly*, March, 1919.

ness offices, the chemical and physical laboratories, the paper plant, the glue laboratory, the wood distillation and preservation laboratories, and several of the drying kilns. A comprehensive exhibit embracing nearly every wood specimen known, together with the library and files, is also in this building. The files contain complete records of the work, and "Technical Notes" is issued by an editorial staff.

The yard has the lumber stock, drying kilns, and small buildings where additional operations are in progress. Among these are the box-testing laboratory, the pulpwood digesters, the fire-proofing test house, etc.

The other buildings shown are occupied by a large amount of equipment and machinery for carrying out the mechanical tests on various woods, and for the manufacture of propellers and structural parts for airplanes. The latter work became highly developed during the war period and will be continued for the Army and Navy Air Services.

The whole aim of the Forest Products Laboratory effort is to promote economy and efficiency in the utilization of wood and in the processes by which forest materials are converted into commercial products.

Pulp and Paper

The laboratory is very well equipped for research in the field of pulp and paper. A complete experimental paper mill with Fourdrinier and cylinder wet ends, two presses, nine drying rolls and a calendar stacker produces paper up to 12 in. in width. Necessary paper-testing apparatus is avaliable in a room where the atmosphere is regulated by a small Carrier Engineering Corporation machine. The digester house is arranged with apparatus for sulphite and sulphate pulp. Fig. 3 shows tumbling soda and sulphate digester in which coniferous woods are converted into wood cellulose for nitration purposes without need of additional purification. Sulphite wood cellulose is also purified in this digester. Fig. 4 shows the upper portion of the sulphite digester with the liquor tank on the left and, on the extreme right, the vat for receiving pulp blown from digester.

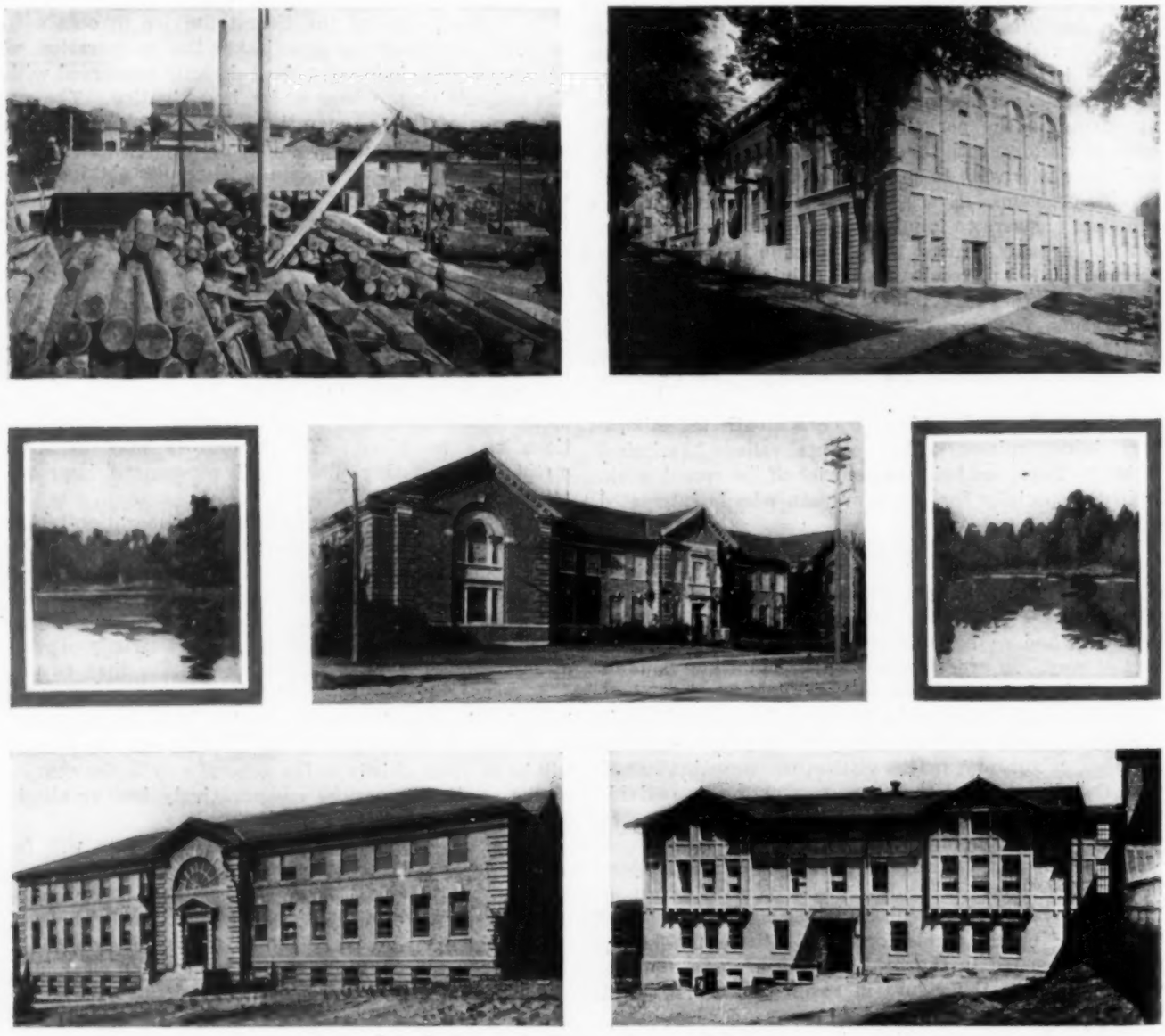


FIG. 1. THE FOREST PRODUCTS LABORATORY

Upper Left—Receiving and storage yard. Upper Right—Where airplane parts are tested. Center—Main building. Lower left —Where the mechanical properties of woods are determined. Lower Right—Building used for experimental propeller manufacture.

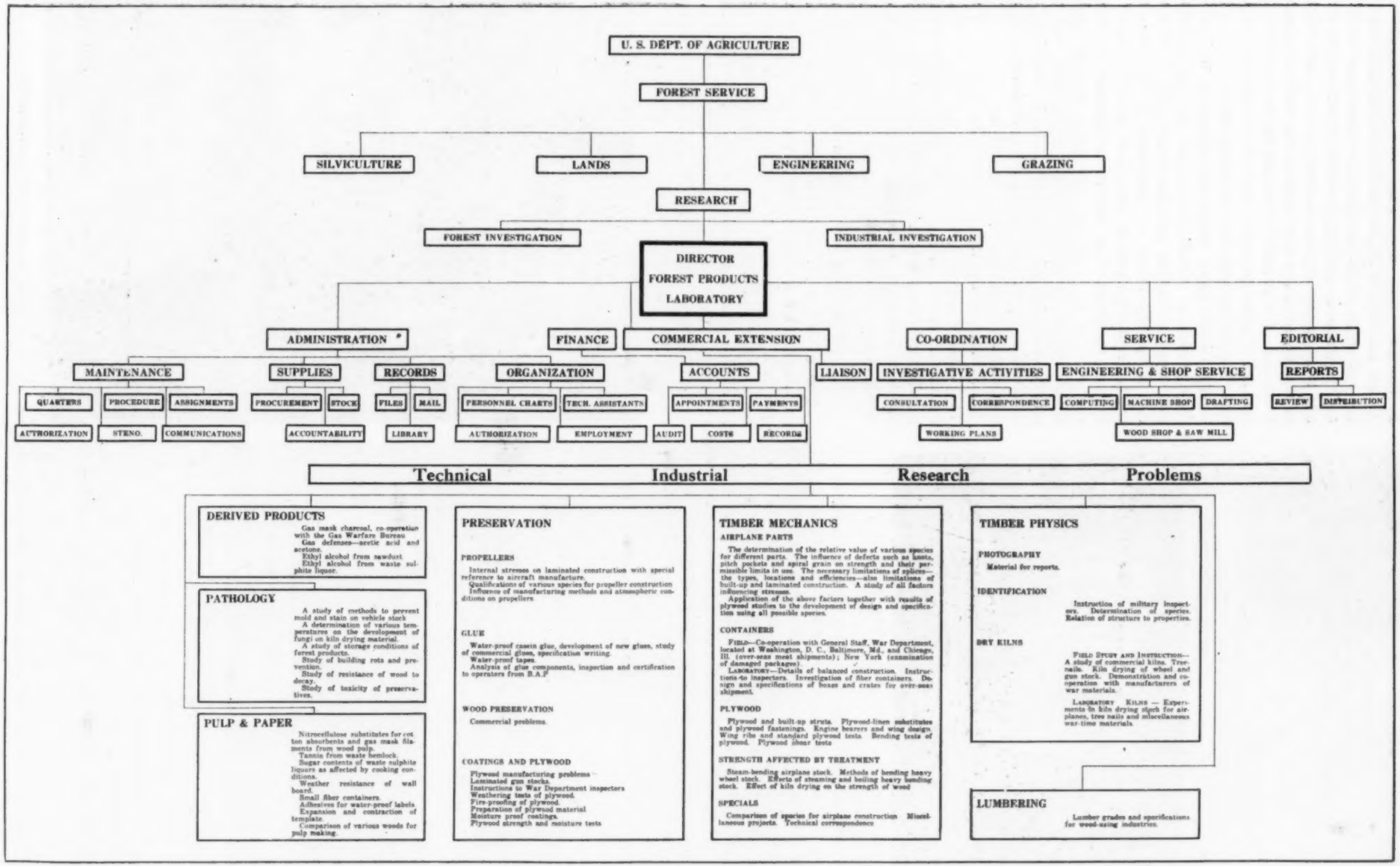

U. S. DEPT. OF AGRICULTURE
FOREST SERVICE
SILVICULTURE
LANDS
ENGINEERING
GRAZING
RESEARCH
FOREST INVESTIGATION
INDUSTRIAL INVESTIGATION
DIRECTOR FOREST PRODUCTS LABORATORY
ADMINISTRATION
FINANCE
COMMERCIAL EXTENSION
CO-ORDINATION
SERVICE
EDITORIAL
MAINTENANCE
SUPPLIES
RECORDS
ORGANIZATION
ACCOUNTS
LIAISON
INVESTIGATIVE ACTIVITIES
ENGINEERING & SHOP SERVICE
REPORTS
QUARTERS
PROCEDURE
ASSIGNMENTS
PROCUREMENT
STOCK
FILES
MAIL
PERSONNEL CHARTS
TECH. ASSISTANTS
APPOINTMENTS
PAYMENTS
CONSULTATION
CORRESPONDENCE
COMPUTING
MACHINE SHOP
DRAFTING
REVIEW
DISTRIBUTION
AUTHORIZATION
STENO.
COMMUNICATIONS
ACCOUNTABILITY
LIBRARY
AUTHORIZATION
EMPLOYMENT
AUDIT
COSTS
RECORDS
WORKING PLANS
WOOD SHOP & SAW MILL
Technical Industrial Research Problems
DERIVED PRODUCTS
Gas mask charcoal, co-operation with the Gas Warfare Bureau
Gas defenses—acetic acid and acetone.
Ethyl alcohol from sawdust
Ethyl alcohol from waste sulphite liquor.
PATHOLOGY
A study of methods to prevent mold and stain on vehicle stock
A determination of various temperatures on the development of fungi on kiln drying material.
A study of storage conditions of forest products.
Study of building rots and prevention.
Study of resistance of wood to decay.
Study of toxicity of preservatives.
PULP & PAPER
Nitrocellulose substitutes for cotton absorbents and gas mask filaments from wood pulp.
Tannin from waste hemlock.
Sugar contents of waste sulphite liquors as affected by cooking conditions.
Weather resistance of wall board.
Small fiber containers.
Adhesives for water-proof labels
Expansion and contraction of template.
Comparison of various woods for pulp making.
PRESERVATION
PROPELLERS
Internal stresses on laminated construction with special reference to aircraft manufacture.
Qualifications of various species for propeller construction
Influence of manufacturing methods and atmospheric conditions on propellers.
GLUE
Water-proof casein glue, development of new glues, study of commercial glues, specification writing.
Water-proof tapes.
Analysis of glue components, inspection and certification to operators from B.A.F.
WOOD PRESERVATION
Commercial problems.
COATINGS AND PLYWOOD
Plywood manufacturing problems
Laminated gun stocks.
Instructions to War Department inspectors
Weathering tests of plywood.
Fire-proofing of plywood.
Preparation of plywood material
Moisture proof coatings.
Plywood strength and moisture tests
TIMBER MECHANICS
AIRPLANE PARTS
The determination of the relative value of various species for different parts. The influence of defects such as knots, pitch pockets and spiral grain on strength and their permissible limits in use. The necessary limitations of splices—the types, locations and efficiencies—also limitations of built-up and laminated construction. A study of all factors influencing stresses.
Application of the above factors together with results of plywood studies to the development of design and specification using all possible species.
CONTAINERS
FIELD—Co-operation with General Staff, War Department, located at Washington, D. C., Baltimore, Md., and Chicago, Ill. (over-seas meat shipments); New York (examination of damaged packages)
LABORATORY—Details of balanced construction. Instructions to inspectors. Investigation of fiber containers. Design and specifications of boxes and crates for over-seas shipment.
PLYWOOD
Plywood and built-up struts. Plywood-linen substitutes and plywood fastenings. Engine bearers and wing design. Wing ribs and standard plywood tests. Bending tests of plywood. Plywood shear tests
STRENGTH AFFECTED BY TREATMENT
Steam-bending airplane stock. Methods of bending heavy wheel stock. Effects of steaming and boiling heavy bending stock. Effect of kiln drying on the strength of wood
SPECIALS
Comparison of species for airplane construction Miscellaneous projects. Technical correspondence
TIMBER PHYSICS
PHOTOGRAPHY
Material for reports.
IDENTIFICATION
Instruction of military inspectors. Determination of species. Relation of structure to properties.
DRY KILNS
FIELD STUDY AND INSTRUCTION—A study of commercial kilns. Tree-nails. Kiln drying of wheel and gun stock. Demonstration and co-operation with manufacturers of war materials.
LABORATORY KILNS — Experiments in kiln drying stock for airplanes, tree nails and miscellaneous war-time materials.
LUMBERING
Lumber grades and specifications for wood-using industries.

FIG. 2. ORGANIZATION OF THE FOREST PRODUCTS LABORATORY SERVICE

FIG. 3. SODA AND SULPHATE DIGESTER

The problem of lining an experimental digester is different in many respects from lining problems in the commercial sizes, the most important difference being due to the size. Other differences arise from the fact that in order to obtain quantitative yields, the experimental digester must be washed free from pulp immediately after each blow, and a lining which spalls off and produces a dirty pulp is unsatisfactory. It is out of the question to riffle the pulp and obtain reliable yields.

Many different kinds of linings were installed before a satisfactory one was found. Because of difficulties due to size, tiling similar to that used in larger sizes could not be used. Lead was first tried, but was soon discarded on account of the "creeping" action when subjected to temperature variations. Bronze produced dirty pulp. A solid lining of litharge and glycerine lasted only a short time. Then cement briquets were made of many mixtures, given different coatings, and subjected to the action of sulphite cooking acid. The results of these experiments led to the installation of a lining of 1 to 1 cement and crushed quartz sand, 3 in. thick and coated with sodium silicate. This held up fairly well for some time, though particles of sand were constantly falling off and causing dirty pulp.

It was finally decided to install a solid stoneware casting of acid-proof tile 1½ in. thick. This offered no difficulties of construction, as the digester is joined in the middle. Liberal tolerances were allowed in all dimensions, and openings difficult to locate were left out in the casting, being chiseled out after the casting was in place and backed by cement. This lining proved to be exceedingly satisfactory.

Future Work on Pulp and Paper

The work of this section completed to date covers the valuation of fifty specimens of American woods for chemical pulp and twenty-five for mechanical pulp; the manufacture of Kraft paper from native woods which can compete with imported pulp; the manufacture of roofing felt from spent hemlock bark; the reduction of 15 per cent waste in the making of ground wood pulp; the reduction of 30 per cent in steam used and 20 per cent increase in density of black liquors in the sulphate and soda processes; the development of a reliable method for determining the tearing strength of paper; the invention of a recording density hydrometer for use in control of soda recovery; and the production of tannin from waste hemlock bark at paper mills.

The future work under consideration will cover the development of standard methods for the purchase of pulp-wood and other raw materials, and their commercial adoption; study of problems in the recovery of waste from the chemical processes, and the use of black liquors, waste sulphite liquors and similar by-products; continuation of work on lumbering wastes and additional species of American woods for pulp and paper; and co-operation with the pulp mills in working out the application on a mill scale of improvements in processes and methods suggested by experience.

Extension of the use of wood-pulp is also under way. This involves the suitability of the species in the manufacture of twine, artificial silk, rugs and textiles, fiber packing containers, articles molded from mixture of asphaltum and pulp, nitrocellulose, gas mask filters, and many other applications.

Preservation—Glue and Plywood

One of the most valuable developments in this department is the manufacture of glue and plywood. The glue is a factor nearly as important as the wood itself, because the finished product is directly dependent for its efficiency on the quality of the glue used in its construction. The uses for plywood are unlimited and its increasing employment in the industries operates directly in the conservation of wood wastes.

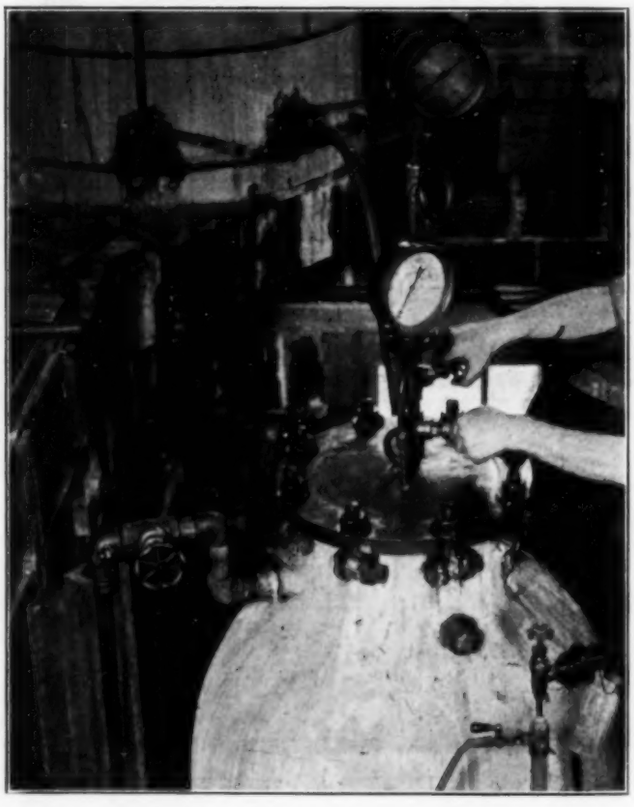


FIG. 4. SULPHITE DIGESTER

It is expected that the next few years will see a marked increase, not only in the use of plywood but in its form of manufacture and its application to various uses. The laboratory has developed new economical and practical manufacturing methods and standard tests to secure uniformity of product, and has determined the suitability of woods heretofore unused for plywood.

Work is yet to be done along these lines and the results will be the basis for the intelligent use of plywood. It has even been predicted that there will be upon the market within a few years houses of the "ready-built" design made almost entirely of plywood construction.

The research work on glues consists of the development and improvement of water-resistant glues, study

FIG. 5. FOAMING TEST FOR ANIMAL GLUES

of commercial glues, analyses and specifications for glue components, glue strength and durability tests, plywood manufacturing problems, and instruction of industrial representatives.

Future activities in glues will embrace studies of glue and plywood manufacture, with reference to particular uses in various industries, improvements in quality and lowering costs of water-resistant glues, development of wide industrial use of waterproof glues, adaptation to furniture and vehicle manufacture, and assistance to makers of glued products in their special problems.

An article on "Water-Resistant Glues" by F. L. Browne of the laboratory was published in CHEMICAL & METALLURGICAL ENGINEERING, Aug. 1, 1919, in which the work was covered in considerable detail. The glues are mixed in an ordinary 3-speed dough mixer as described, and are tested in several ways. The standard test for tendency of glue to foam is shown in Fig. 5, the glue being stirred mechanically in a glass of standard size. The amount of foam formed is measured after a given time, and also the time consumed in subsiding is noted. Glue which foams badly may give unsatisfactory joints.

After the glue is applied and set in a plywood specimen, test of shearing strength of glued joints is made in the specially adapted Riehle cement briquet testing machine as shown in Fig. 6. The jaws were made in the laboratory shops. The strength of a glued joint depends not only on the chemical and physical qualities of the glue but also on the pressure exerted in the veneer press when the joint is setting. Either an excess or a lack of pressure weakens the joint. Standard formulæ have been worked out for this feature.

The data available from experiments completed cover a wide range of valuable information. Specifications have been made for glues purchased by the Army and Navy Departments, together with standard analyses. Moisture-proof coatings have also been developed.

Future research on plywood will include shrinkage factors for plywood of different species, accurate information as to strength and design of nail, screw and other fastenings for plywood, studies of warping and effect of vibration on plywood, effects of high temperatures on strength, absorption of moisture under varying humidity and effect on strength, and study of special adaptations in the industry.

PRESERVING WOOD

Losses due to decay of timber used in construction, poles, posts, piling, ties, etc., reach a high figure annually. Considerable work has been done to prevent this. Fig. 7 shows the equipment used in the labora-

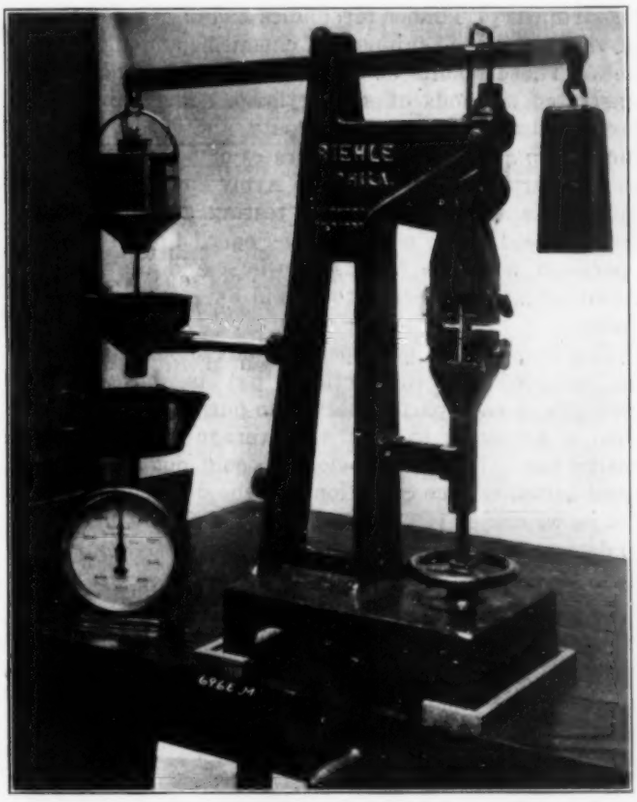


FIG. 6. RIEHLE MACHINE FOR TESTING GLUED JOINTS

tory for the pressure treatment of wood for both preservation against decay and fire-resistant compounds.

The new work in this section will involve a study of preservatives to improve those now in use; new preservatives for salt water piling; improvements in preservative manufacture; determinations of wood penetration by preservatives to obtain better methods of treatment; an investigation of the fundamental prin-

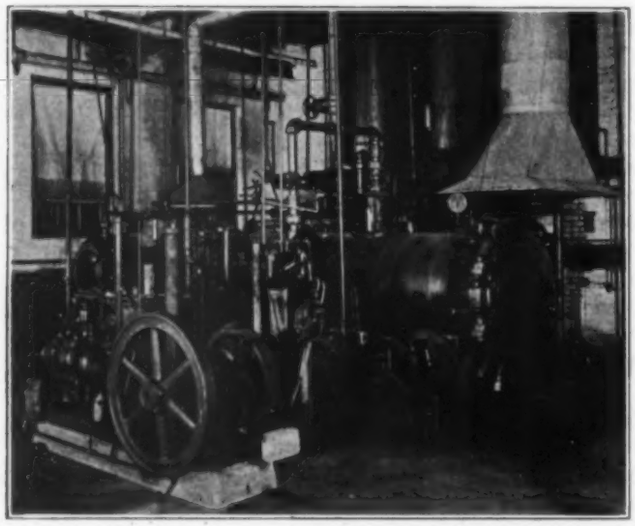


FIG. 7. WOOD IMPREGNATING RETORTS

ciples of decay and of the causes of deterioration of wood in buildings; and studies in fire protection both by changes in construction and fire-retardant compounds.

Packing Containers

While the work of this section does not depend on the chemical laboratory for its results, nevertheless the Department of Timber Mechanics has discovered things of vital interest to shippers of chemicals and allied products. These results of box laboratory tests have demonstrated methods of saving large sums annually in freight, damage to goods en route, and conservation of lumber, to all shippers using crates or boxes. Previous to the starting of tests for the Army Ordnance Department no adequate method of testing a container had been devised. The work is being carried on in close cooperation with the box associations and the Railroad Administration in order to obtain data of the greatest value.

The properly designed packing box should first of all be balanced in construction, that is, have enough strength in each part to serve the purpose and no more than is necessary to equal the average strength of the entire box. The data obviously could not be collected from actual service conditions, as the destruction would not be witnessed in sufficient detail, so it was necessary to devise methods of test which would approximate service conditions and combine practical experience in box design with these tests.

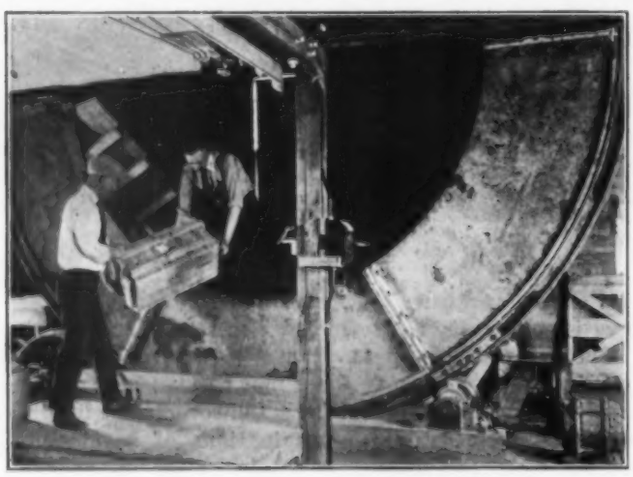


FIG. 8. LARGE BOX TESTING MACHINE

The compression-along-the-edge test is a steady and constantly increasing pressure (measured in pounds) applied along any edge with an opposite edge diagonally through the box in direct line with the pressure exerted. The cornerwise test is applied through diagonally opposite corners in the same manner. These two tests measure the resistance of a box to external pressure, but are insufficient to determine weaknesses and balanced construction. In comparing one box with another the drop test is of value. This consists of dropping a box on one corner from a specified height when loaded with contents. All these tests, however, are very much limited.

FIG. 9. SMALL BOX TESTING MACHINE

The new method consists of placing the box with contents in a hexagonal drum and slowly revolving the drum until the box is broken. Within this drum a regular cycle of drops of the box is arranged so it falls upon sides, top, bottom, ends, edges, corners and flatwise upon steel studs similar to corners of another box. This gives all the conditions of actual service except heavy pressure received in lower tiers of a pile. This is determined by the compression-on-edge test hitherto mentioned.

During the time the box is revolving in the drum each weak feature may be noted as it develops. Nails may pull out, material may split, and the observer, by repeated experiments, will eventually arrive at a box that is equally strong in every feature. Such defects in the wood as affect the proper efficiency of the container must be eliminated, but others not harmful to the balancing of strength should be allowed to remain, to keep down the cost of manufacturing.

Fig. 8 shows a part of the large machine used. It is about 18 ft. in diameter, with a hexagonal interior. The operator views the interior from the switch shown on the post or from the platform shown overhead. Fig. 9 shows the smaller machine in operation. The factory

of every box-maker should contain one of these machines, for this method of "proof of the package" overshadows all the crude tests heretofore employed.

It discovers the size, quality and shape of lumber needed. It proves the kind, size and spacing of nails, the quality, size and location of metal strapping, the type of handle best employed, and all the special features required for the article to be packed.

The majority of the containers tested have been proved 15 to 20 per cent too heavy and occupied a like amount of excess space. Fig. 10 illustrates a crate designed to supersede a heavy box and employing the three-way corner construction. For foreign shipment of ordnance material the redesign of a box to carry thirty 1-lb. cans of saddle soap saved 43 per cent in cargo space. A redesigned cannon powder box carrying 140 lb. of powder saved 14 per cent space. Twenty-eight per cent of space was saved on a box for two Browning automatic machine guns, and 33 per cent on one for ten rifles. Official reports from France show that the broken package loss was only 15 per cent of that formerly occurring, which compares favorably with domestic shipments.

The future field for container research at the laboratory is at once seen to be large. The lines laid down for new work call for a determination of the best methods of box and crate construction; study of fiber and corrugated container design; design of barrels and baskets; finding the relation between weight of contents and thickness of material; preparation of specifications for domestic and export boxes; application of various types of strapping; study of holding power of nails; designs to use up short lengths of lumber; and a comprehensive study of records of loss and damage to shipping containers and methods of overcoming present losses.

Other work in timber mechanics has been extensive operations in airplane design. One feature of interest is the bending of heavy stock for artillery wheels as shown in Fig. 11. Many machines located throughout the laboratory are used for mechanical tests. Built-up sections of airplane beams, struts, ribs and operating parts are in the course of construction. These pieces

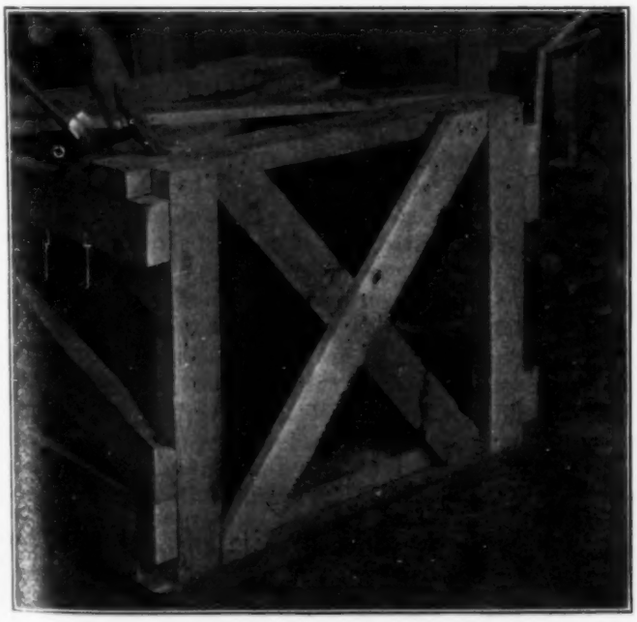


FIG. 10. ECONOMICALLY DESIGNED CRATE

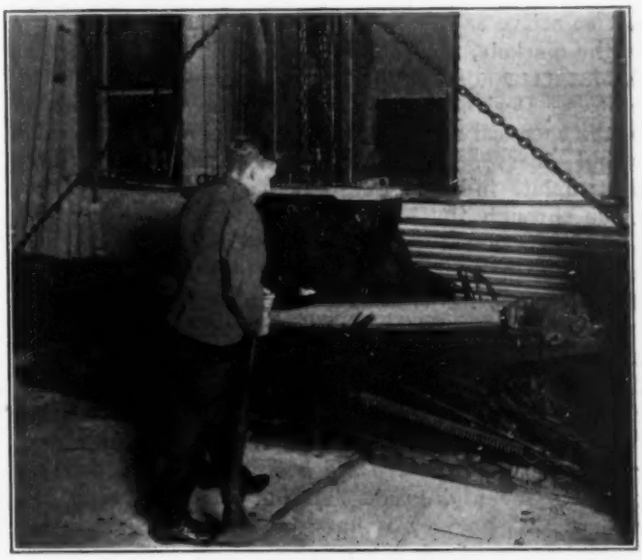


FIG. 11. BENDING WHEEL STOCK

show some valuable examples of wood fabrication for general application, and structural designers in the chemical industries may study them with profit.

Even a brief view of the operations is an education in mechanical design involving the use of timbers. Exhaustive tests are conducted on plywood and glued joints as well as those of specific articles of manufacture. Information furnished by this department is of great value to engineers, architects and manufacturers.

Timber Physics

The dry kiln section renders service to all industries through the improvement in mechanical resistance of kiln-dried wood as compared to green timber. The majority of kilns in use are patterned after the Forest Products Laboratory kiln. It is hoped that the consumers of wood will ultimately see the advantage of using a kiln-dried product for all purposes.

The kiln consists of a brick-walled rectangular structure, heated within by steam coils. In addition to the steam piping a series of water sprays, located along the sides, furnish an air draught throughout the interior, at the same time giving the proper humidity to the atmosphere. The control of both temperature and humidity is entirely automatic.

The future work on drying will involve a continuation of studies on the effect of drying on additional species; requirements for the greatest strength and reduction in drying time; extension of exact information concerning the proper methods of certain refractory species like swamp oaks, the value of which is limited by seasoning difficulties; reduction of working formulæ to simplest terms when dealing with raw wood; and the making more accessible to manufacturers of lumber, vehicles, aircraft, freight cars, furniture, and interior finish, the basic data that have been evolved.

Additional work on kiln design proper will embrace the determination of types best suited to different kinds of work; perfection of kilns capable of accurate control at least cost; extension of basic information on improvement of commercial kilns now in use; investigation of various types now on the market; and supplying data to the industry for installation of better kilns.

The division on Derived Products is of the greatest interest to those who think in ways chemical, and while

not so active as others at the present time, due mainly to the markets, it will nevertheless entertain CHEMICAL & METALLURGICAL ENGINEERING readers with its possibilities. Derived products, as in many other branches of the chemical industry, can be made from parts which would otherwise be wasted, a fact truly delightful to contemplate in these days when so many savings are made through the aptly called by-products.

Complete apparatus is installed for study in connection with wood distillation. Hardwoods previously thought unfit have been found available, causing the installation of new plants throughout the country. A method of controlling temperature of distillation has been developed which increases the production of calcium acetate 8 to 12 per cent and of wood alcohol 5 to 10 per cent. Tar still control has been improved, effect of wood moisture has been studied and new tar products for high-grade flotation oils have been discovered. The pine oils have become standards in the concentration of sulphide ores.

The cup and gutter system of turpentine orcharding developed by research is an example of the improvement in production of naval stores. Acetic and acetone work for airplane dope, gas mask charcoal from wood, carbon monoxide absorbent for gas masks, and the production of tear gases, poison gases and munition chemicals have all contributed to the utilization of wood wastes during the war. An oil-jacketed still for operation under constant temperature is used largely in distillation tests.

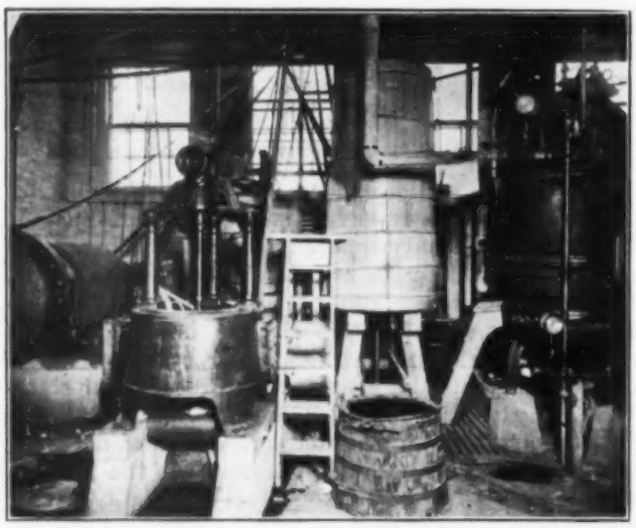


FIG. 12. ETHYL ALCOHOL FROM WOOD AND SULPHITE LIQUOR

In spite of the fact that we no longer are permitted to absorb ethyl alcohol directly, it nevertheless has an increasing use in pharmaceutical and cosmetic preparations. The laboratory has installed a complete plant for the production of ethyl alcohol from wood and sulphite waste liquors, shown in Fig. 12. The wood cellulose is converted into fermentable sugars by treatment with acid.

Other products derived from the forest growths are tannins, essential oils from bark and leaves and wood producer gas. Chemical derivatives from cellulose are also susceptible to development. A gum which is in demand by manufacturers of perfumes, tobacco, adhesives and drugs is produced from the red gum tree of the Southern States, though few owners realize its commercial value. Cinnamic acid and cinnamic alcohol are two of its valuable components.

Future investigations are contemplated in production efficiency and uses of turpentine, rosin, grain alcohol, acetic acid and charcoal; studies will be made to develop practical processes of value concerned with comparative yields of wood, increasing yields of valuable products and improved methods of refining products; classification of methods applied to wood species and quality, and value of products will be sought; the production and new uses of tar oils will be developed.

ADDITIONAL FUTURE RESEARCH

Although the large amount of effort put forth under high pressure during the period just past has given a wonderful impetus to forest products investigations as well as operations in the field on a commercial scale, the interest should be maintained. An extensive program of work is planned in addition to that covered here.

Industrial strength requirements have been demonstrated through present limited knowledge to be important. Determinations of the fundamental laws governing the strength of wooden columns, of the strengths of different wood species for use in telephone poles, etc., of definite factors of safety for beams under continuous loads, of efficiency of joints and fastenings in wooden structures, and conditions where low-grade woods may be used are all of commercial interest. Data must be obtained on use of wood for rebuilding railway cars, and also comparative data on strengths of commercial woods.

General lumber study will be developed to obtain data for cost accounting and timber appraisal, to obtain information on woods of the United States suitable for export, to determine new uses and markets for lumber as made possible through the development of plywood, built-up construction, etc., and to solve economic problems of lumber supply and distribution of finished products. The field work calls for liaison with lumber manufacturers, veneer and panel makers, vehicle and implement manufacturers, box makers, shippers, pulp and paper industry, turpentine, rosin and glue producers, dairymen, leather and tanning industries, railroads, engineers, architects and technical professions, fire underwriters, chemical industries, and others dependent on wood products.

PRACTICAL RESULTS OF THE FOREST PRODUCTS LABORATORY WORK

The years occupied in research by the Forest Service have borne fruit in the production of a large amount of data of general service to many industries and individuals, and copies of results may be had for the asking. The range of effort is so wide and the ramifications of the work so far reaching that it has been possible to mention only a few features in this article, with the hope of arousing the interest of those who may not be familiar with the more active phases, thereby bringing them in touch with the laboratory to the ultimate benefit of the industry.

The net gain in wealth to the nation through the activities of the Forest Products Laboratory is so great that adequate funds from general taxation should be always available for its financial support.

We are indebted to Mr. Rolf Thelen, acting director, for information making possible the preparation of this article.

Resistance of Absorption Tower Packing to Gas Flow*

BY FRED C. ZEISBERG

THE past few years have seen an enormous increase in the manufacture of various types of tower packing, and several patents have been taken out on designs developed by various inventors and manufacturers of chemical pottery. Acid manufacturers have been quick to recognize the advantages possessed by these manufactured packings, and have largely replaced the pumice, quartz or coke formerly used, with rings, blocks, and other shapes. While an improvement in absorption has nearly always accompanied the adoption of one of these modern packing materials, no numerical method of expressing this advantage has been available except the figures on surface and free space, quoted by the manufacturer of the packing, and these are frequently erroneous.

For this reason the E. I. duPont de Nemours & Co. undertook a study of various types of tower packing, with the purpose of checking up definitely the surface and free space figures not only of the artificial packings, but also of quartz and coke, and more important still, to investigate the resistance to gas flow offered by the various types of packing in common use. In large absorption systems the resistance is an important consideration, since if improperly designed, the system will require excessive pressures to bring about the necessary gas flow. It was hoped that the data obtained would stimulate packing manufacturers to produce newer and still better types of packing.

The projected study was mentioned to Mr. Hood, of the B. Mifflin Hood Brick Co., and he very kindly offered to donate such of his products as we might wish to test. His offer was accepted and the following packing material was furnished by him: 3 x 3 in. corrugated diaphragm rings, 3 x 3 in. corrugated spiral rings, 6 x 6 in. corrugated spiral rings, 6 in. Hechenbleikner blocks and 1½ x 4 x 8 in. chemical ware tile. The General Ceramics Co. also loaned us a supply of 1-in. Raschig rings.

Figures for the surface of the packing materials were calculated from measurements, and are expressed as "square feet per cubic foot." Since many of the British journals express this figure as "square yards per cubic yard" and the French and German journals as "square meters per cubic meter," it may be desirable to point out here that all of these values are of a different magnitude. One square foot per cubic foot is equivalent to 3 square yards per cubic yard or 3.28 square meters per cubic meter. With quartz and coke, of course, the measurements are approximate only, and consequently surface figures for these materials do not possess the accuracy of those for the manufactured packings. It might be well, also, to point out that in the case of the manufactured corrugated packings the assumption was made that the corrugations did not add anything to the surface, which is not strictly true.

*Read at the Savannah meeting of the American Institute of Chemical Engineers, Dec. 3-6, 1919.

FRICTIONAL RESISTANCE TO GAS FLOW

The free space of a packing is the intersticial space. It is the space through which the gas must pass and is expressed as a percentage. Thus, a free space of 50 per cent means that in 100 cu.ft. of packing material 50 cu.ft. of gas passages exist. The free space herein reported was obtained by taking into consideration the number of pieces of packing required to fill a known volume, together with the average weight per piece and the apparent specific gravity of the packing material, or by actually weighing the amount of packing material whose apparent specific gravity was known which was required to fill a known volume. The free space naturally varies with the type of packing and with the manner of disposing it in the tower.

The resistance offered by a tower packing to gas flow is of course dependent upon both the free space and the surface exposed, but just what effect each might have it is impossible to predict. For this reason air was actually blown through a variety of packings under various conditions and the resistance was actually measured.

Experimental equipment consisted of a Wilbraham Green positive-pressure blower connected with a series of chemical ware absorption towers 30 in. in diameter and approximately 15 ft. high. The air passed into the bottom of each tower in succession, being carried from the top of one tower to the bottom of the tower

TABLE I—CHARACTERISTICS OF VARIOUS TOWER PACKINGS

Packing	f_{dy}	f_{dw}	f_{dc}	f_{sy}	f_{sw}	f_{sc}	f_{py}	f_{pw}	f_{pc}	Per cent free space	Surface sq.ft. per cu.ft.	Weight lb. per cu.ft.	No. units per cu.ft.
	×10⁻⁷												
Quartz, 6 in.	58	60	60	..	..	..	..	..	..	44	6.3	89	..
Quartz, 3 in.	101	110	139	..	..	..	..	..	..	46	12.7	86	..
Quartz, 2 in.	384	396	433	..	..	..	..	..	..	46	18.7	88	..
Quartz, ½ in. to 1 in.	672	865	1095	..	..	..	..	..	..	47	50.3	88	..
Coke, 3 in.	76	81	94	..	..	..	..	..	..	58	12.7	29	..
Coke, ½ in. to 1½ in.	215	380*	..	..	..	..	..	..	..	..	..	..	..
4 in. x 3 in. smooth diaphragm rings	51	56	63	25	34	38	..	32	34	64 (1) 51 (2) 51 (3)	20.0 27.0 27.0	50 66 66	27 36 36
3 in. x 3 in. corrugated diaphragm rings	51	56	63	31	42	58	26	28	28	65 (1) 57 (2) 55 (3)	24.0 30.0 31.0	48 61 63	53 67 70
3 in. x 3 in. corrugated spiral rings	45	54	63	54	54	61	..	..	..	72 (1) 64 (2)	22.0 29.0	40 53	48 63
6 in. x 6 in. corrugated spiral rings	..	..	..	38	47	50	24	3	35	58 (2) 58 (3)	15.0 15.0	53 53	8 8
6 in. corrugated Hechenbleikner blocks	16	36	36	35	38	38	26		28	72 (1) 62 (2) 62 (3)	10.7 14.3 14.3	39 52 52	4.2 5.6 5.6
1 in. Raschig rings	345	345	345	..	..	..	..	..	..	73	58.0	40	1350
Tile on edge, unstaggered	..	..	..	..	..	..	31	31	43	59	10.5	62	16
Tile on edge, staggered	..	..	..	..	..	..	18	24	31	75	6.4	35	9.5
Tile on edge, staggered	..	..	..	..	..	..	31	33	35	55	11.6	68	17.5
Tile on edge, staggered	..	..	..	..	..	..	43	43	74	45	14.0	81	21
Tile staggered, alternate rows flat	..	..	..	..	..	..	41	48	57	49	13.2	77	20

* Wet with 92 per cent sulphuric acid instead of water. (1) dumped. (2) stacked. (3) packed.

following by an 8-in. pipe. A valved side connection in the pipe to the first tower was provided, so that the amount of air passing into the tower could be regulated by spilling the excess to the atmosphere. The air passing into the tower was measured with a glass Pitot tube of the American Blower Co. type, while differential manometers, protected from velocity pressure effects, were provided at the bottom and top of each tower to measure the static pressures at those points. A carefully measured height of the packing to be tested was supported on a checkered brick pier in the bottom of the tower. The resistance offered by this pier to an air flow much larger than is ever likely to be met in practice was actually determined to be negligible. In some cases a series of measurements was made simultaneously in several towers, but since the results thus determined were found to be in good agreement the later tests were run on only one tower.

Derivation of Constants

Since the constants which are shown in Table I, together with other characteristics of various types of packing, will be unintelligible without explanation, it is desirable at this point to give some attention to the theoretical considerations involved.

Assuming that the general law of the flow of fluids holds in this case (this was experimentally demonstrated to be true), the frictional resistance is proportional to the square of the velocity of flow. This resistance may be expressed as the pressure necessary to produce the given flow.

Let s = linear velocity in ft. per. min.
p = pressure in inches of water
k = a fractional constant
a = area of cross section of packing in sq.ft.
h = height of packing in ft.
v = volume of air passing in cu.ft. per min.

$$\text{Then } p = \frac{ks^2}{v} \tag{1}$$

$$\text{and } s = a \tag{2}$$

$$\text{Therefore } p = \frac{kv^2}{a^2} \tag{3}$$

Since the resistance or the pressure varies directly as the height of the packing we may write

$$p = \frac{khv^2}{a^2} \tag{4}$$

However, k is a general constant, varying in value with the type of packing. We have therefore designated f as the frictional coefficient of 1 sq.ft. of packing 1 ft. high, and may write equation (4) as

$$p = \frac{fhv^2}{a^2} \tag{5}$$

f of course differs for each style of packing, with its method of disposal in the tower and with the amount of liquid circulating in the tower. In order to make f more descriptive, subscripts have been added, as follows:

f_d = packing dumped into tower
f_s = packing stacked, i. e., arranged regularly in layers, but with no attempt to have pieces in one layer in any way related to those in adjacent layers.
f_p = packing packed, i. e., arranged regularly in layers, with the axes of pieces in adjacent layers coinciding.
f_y = packing dry.
f_w = packing wet with water, but drained as completely as possible.
f_c = packing with water circulating over it at a rate of 11 lb. per sq.ft. cross sectional area per min.

It is, of course, evident that we may have, for example, f_{dy} = packing dumped and dry, and that quartz or coke can give values only for f_d and not for f_p or f_s.

The frictional coefficient was then determined for various packings under various conditions, by measuring the pressure drop through a tower filled to a known height with the packing and calculating this value to the standard condition of a 1-ft. cube. These values of f, together with other characteristic data, are given in tabular form in Table I. It should be emphasized that the frictional coefficient values are not accurate to more than two significant figures, and in some cases the second figure is in some doubt.

Variation of Resistance With Packing Sizes

These figures speak for themselves; nevertheless, a few of the more obvious facts will be pointed out. For instance, it is interesting to note how rapidly the resistance to gas flow increases with decrease in size of material (see quartz). That this resistance is not entirely a function of the surface exposed by the packing is indicated by the fact that as the size decreases the resistance increases first less rapidly than the surface and then considerably more rapidly. Another interesting fact is the increase in resistance, with the smaller packings, due to a mere wetting of the packing. Often the difference in resistance between a dry and a wet packing is greater than the difference between a merely wet packing and the same packing with considerable water circulating over it.

Perhaps the most noticeable thing brought out by Table I is the fact that for a given size of packing the manufactured packings give much more surface and greater free space and interpose much less resistance in the absorption system than quartz, coke or packings of that kind. Many other points will be obvious to the reader.

Problem and Solution by Use of Constants

An example of the application of the resistance constants may not be amiss. Suppose it is desired to find out what pressure will be necessary to force 250 cu.ft. of air per minute through an absorption system composed of 5 towers 2 ft. in diameter and filled 10 ft. deep with absorption material, when 3-in. quartz is used or when 3-in. spiral rings, stacked, are used, the rate of water circulation being 5 lb. per sq.ft. cross sectional area per minute.

The cross sectional area of the packing is $\frac{\pi 2^2}{4} = 3.14$ sq.ft. The total height is $5 \times 10 = 50$ ft. For quartz f_{dy} would be about $120 \times 10^{-7} = 0.000012$, and for spiral rings about $58 \times 10^{-7} = 0.0000058$ (since the rate of circulation for f_c in Table I was 11 lb. per sq.ft. per min., values are assumed about halfway between f_w and f_c).

We have seen from equation (5) that the pressure is $p = \frac{fhv^2}{a^2}$, or, substituting numerical values for f, h, v, d,

$p = \frac{0.000012 \times 50 \times (250)^2}{(3.14)^2} = \frac{0.000012 \times 50 \times 62500}{9.88} = \frac{37.5}{9.88} = 3.8$ in. water for quartz. For spiral rings the pressure would be $3.8 \times \frac{0.0000058}{0.000012} = 1.8$ in.

In closing this paper the writer wishes, first, to thank E. I. duPont de Nemours & Co. for permission to publish these results, and, second, to acknowledge the great assistance of Dr. Guy B. Taylor in obtaining the figures, the actual carrying on of the experimental work being in his hands.

Use of Rosin in Paint and Varnish*

By Maximilian Toch

AS FAR back as any man in the paint and varnish industry can remember, rosin has not only been despised, but its general use has been discouraged by paint chemists, and endless numbers of tests have been devised so that as a paint and varnish material its use has been discouraged. In addition to that, manufacturers have always been more or less ashamed to acknowledge that they have used it; and, so far as I am personally concerned, I have never been a believer in it, excepting for the manufacture of resinates as driers, because up to within a few years ago no rosin varnish or paint oil containing rosin had been made which had much merit. Up to 1914 there was hardly a specification that I know of that did not read similar to the following one which I quote.

Cabinet Rubbing Varnish

Composition—To be made exclusively from the best grade of hard varnish resins, pure linseed oil, pure spirits of turpentine, and lead manganese driers, and be free from all adulterants or other foreign materials.

Paint Drier

Composition—To be composed of lead, manganese, or cobalt, or a mixture of any of these elements, combined with pure linseed oil and hydrocarbon solvent, and to be free from adulterants, sediment, and suspended matter. Resins other than rosin may also be used at the option of the manufacturer.

Japan Drier

To be made of varnish gums, linseed oil, turpentine and lead and manganese driers. Common rosin, benzine and similar adulterants must be absent.

Spar Varnish

Composition and Quality—Spar varnish shall be made exclusively from the best grade of hard varnish resins, pure linseed oil, pure spirits of turpentine and lead-manganese or cobalt driers, and shall be free from all adulterants or other foreign materials.

It is not my intention to go deeply into the chemistry of rosin, because the material is well known and has specific characteristics. Suffice it to say that rosin is obtained from the sap of certain species of pine trees. This sap is collected by scarifying the tree and collecting the sap, which solidifies under the name of "gum thus." When this "gum thus," which is a yellow, viscous, semi-hard and waxy looking material, is distilled, it yields turpentine by condensation and rosin remains behind.

Rosin is a brittle, soft resin, which ranges in color from a pale yellow glass-like looking substance to a very dark brown, almost black solid. It melts very readily and is practically fluid at the temperature of boiling water. Under ordinary circumstances, when converted into a paint oil or into a varnish, it turns white and becomes friable when subjected to even slight moisture and rubs off very readily when even slight friction is applied. It is so highly acid that lead and zinc, or other basic pigments, cannot be mixed with it, for it forms resinates so rapidly that the resulting material "livers," or becomes semi-solid or gelatinous before it can be entirely applied or consumed. It does not stand water, and when used as a furniture varnish it becomes soft and sticky on a rainy day; and, all in all, it has been regarded as a totally unfit material for paint or varnish purposes. Yet, the great reason for its use has been that there is nothing like it so low in price, and consequently it was a ready adulterant for the higher priced and better resins.

A Typical Case

Speaking again of the specifications which prohibited its use, I recall a case some years ago where a manufacturer furnished under a Government specification a large quantity of spar varnish for boat use, and the specification read that the varnish was to be composed of fossil or semi-fossil resins reduced with linseed oil and a proper solvent and drier. The varnish was delivered and was rejected, because it gave the Liebermann-Storch color reaction for rosin.

The manufacturer contended that he did not put rosin in the varnish as an adulterant, and the Government claimed that the specifications had been violated; and, in order to settle this matter and prevent a law-suit, the Government selected me as an arbitrator and the manufacturer did the same. On investigation, I found that a very small percentage of rosin had been used to "grease the kettle" in order to prevent the discoloration of the fossil resin by melting, and I therefore decided in favor of the manufacturer. But this, and many other examples that I could cite, indicate that rosin as a paint material, and more particularly as a varnish compound, has been largely discouraged for the reasons that I have cited:

First.—Because it is no good.

Second.—Its price has been so low that it was used as an adulterant or a cheapening material.

History of China Wood Oil

But the advent of china wood oil has brought about a change, and I am unafraid to admit that, while I despised and discouraged the use of it in my own factory, I am now a firm believer in it; and, until something better can be discovered, rosin has at last come into its own.

Let us remember that fifteen years ago china wood oil was condemned because its physical characteristics were compared with linseed oil, which shows us that it is a mistake to take a new material and judge it by an older one. Raw linseed oil, as everyone knows, dries with the aid of a drier, and when suitably mixed with the proper pigments forms a film which lasts anywhere from three to eight years, even under extreme exposure.

Raw china wood oil, on the other hand, no matter what it is mixed with, dries with an opaque, brittle, crystalline film, which is neither flesh nor fowl. It polymerizes or solidifies when heated for twenty minutes to 420 deg. F. (216 deg. C.). It is difficult to manipulate and in unskilled hands it is a failure. But when 4 lb. of china wood oil is heated with 1 lb. of rosin that

*Read before the American Institute of Chemical Engineers, Dec. 5, 1919, Savannah, Ga.

has been partially or wholly converted into a resinate of lead or similar compound, the heat can be carried up to 600 deg. F. (315 deg. C.) without danger of the polymerization of the oil, and a varnish is obtained which, while fairly high in acid number, possesses more remarkable qualities than the best kauri linseed oil varnish ever made. This sounds strange, but it is true.

Of course, to those skilled in the art it is known that this resultant fusion of 5 lb. just mentioned must be diluted with equal quantities of turpentine or turpentine substitute, and the film so produced will not turn white after it has been permitted to dry thoroughly, even though the test sample is placed in water for weeks. When I made my first experiments along these lines I did not use the material as a varnish, but I used it as a paint oil. Of course, lead and zinc could not be used as bases, because chemical union would take place, and the compound, which I called a tungo resinate of lead or zinc, was formed, which was a viscous, ropy, gelatinous material, physically unfit for making paint ready for use. But, if the proper pigments were selected, such as graphite lithopone, red oxide and blanc fixe, a paint could be made which remained in suspension for a long time.

As many know, I do not rely upon laboratory experiments for the finding of my conclusions; but in 1915 and 1916 I made several hundred gallons of various colored paints, omitting linseed oil entirely as a vehicle, and substituting for it a varnish made from rosin and china wood oil, and these paints I applied to wooden structures on the Atlantic coast which were from 100 to 500 yd. distant from low tide and subject, therefore, to the heavy sea fogs of that locality. In comparison with these tests there were a number of smaller buildings painted with various mixtures of lead and zinc and linseed oil, and the conclusions arrived at were that the gloss and hardness of the resulting film, after three years, was as good for the rosin:china wood oil mixture as for the linseed oil paint, with this exception—that the rosin:china wood oil paint left a better surface for repainting.

Reversal of Status of Rosin

Rosin forms esters with certain alcohols like glycerine and phenol, in which the rosin acts as the base and the alcohol as the acid; so that, under certain circumstances, if we follow the experiments of Schall and use a silver-lined or aluminum kettle, we get a glyceride of rosin which is soluble in china wood oil at temperatures up to 600 deg. F. (315 deg. C.), and the resultant varnish has a very low acid number ranging between 7 and 15, which makes it more suitable for mixtures with lead and zinc. But, used alone, rosin esters produce waterproof varnishes which are so far superior to the linseed oil-fossil resin varnishes that the newer specifications of the Government not only permit their use, but encourage it. Specifications used by the Railway Commission and other branches of the Government service are quoted below:

Railway Finishing Varnish

It must be resistant to air, light and water. The manufacturer is given wide latitude in the selection of raw materials and processes of manufacture, so that he may produce a varnish of the highest quality. Preference will be given to rapid drying varnishes.

Flat Finish Interior Wall Paint

The paint supplied must be ready for use for finish coat work. There shall be present not less than 65 or more than 70 per cent of pigment. The vehicle must be composed of treated oils and volatiles, or varnishes which produce a satisfactory washable flat finish.

Deck and Floor Paint

The vehicle shall consist of linseed oil and sufficient waterproof varnish to give the paint a high gloss and resistance to abrasion and water. The varnish in the paint shall conform to the general specifications for varnish.

Spar Varnish for Use in Airplane Construction

The manufacturer is given wide latitude in the selection of raw materials and processes of manufacture so that he may produce a varnish of the highest quality. Rapidity in dust-free drying and final hardening is essential.

It may interest the public to know that nearly all automobiles are varnished nowadays with varnishes of this type. There again, I have conducted a large series of experiments, having painted and varnished no less than twenty automobiles in the last four years with this particular type of varnish. I have the record of one particular automobile which, after one year of hard service in all kinds of weather, is still brilliant and glossy and does not need revarnishing. Rain, sleet or snow has no effect on a varnish of this type and does not produce the well-known bloom or bluish spots so familiar to those seen in linseed oil varnish.

Since the war the price of rosin has risen until it is today such a high-priced material that we will not frown down upon it on account of its low price.

Once Despised Materials Now Precious

Human nature is very peculiar with reference to the embrace of materials which once were despised and come under the category of that well-known stanza in Pope's Essay on Man—"We first abhor; then pity; then embrace." Everyone of us can remember when the metal platinum was only used in the laboratory because of its insolubility and high melting point. Its price when I was a student was about one-third that of gold, or even less. As the price rose and it became a really expensive material, two and a half times dearer than gold, it was fashionable to use it as a setting for diamonds, even though its color was leaden and the polish soon dimmed. Now that platinum is worth five times more than gold, it is idolized by the rich only, it would seem, on account of its price.

Turpentine has always been regarded as the ideal paint solvent, and specifications, tests and laws have been made to prevent the adulteration of turpentine with the petroleum products. Yet in 1911, the price of gasoline in Italy was twice that of turpentine. Furthermore, there was no tax on turpentine, but there was one on gasoline, and it was a criminal offense in Italy to adulterate gasoline with turpentine.

A hundred and fifty years ago, when a good slave was sold in the South, particularly along the coast, the deed usually recited that the slave must not be fed on terrapin, which, as you know, is a species of turtle that was once so abundant that it was even despised by the negroes as food. But when the terrapin became rare, and finally a small portion of it—hardly more than 100 grams—sold in restaurants for $3.50. only the elect few and the newly rich regarded it as fashionable to eat terrapin.

Five years ago rosin sold at about 2c. a lb., and today it has gone to 10c. a lb. Legitimate uses of rosin will raise its price so that who knows but some day it will be considered criminal to adulterate rosin with the fossil resins of the Orient?

Electric Furnace for Experimental Work*

By F. A. J. FitzGerald and Grant C. Moyer

IN OUR work we have found that for a variety of small-scale experiments the furnace which is shown in the drawings illustrating this note and which we use in the laboratory has been found by us convenient and satisfactory.

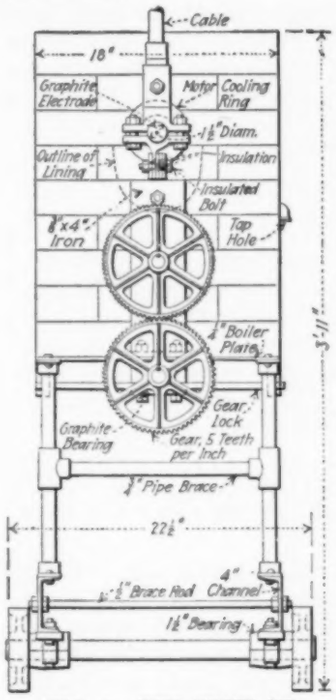


FIG. 1. END VIEW OF FURNACE

The furnace is mounted on a truck built of channel irons, a pipe framework and boiler plate. The electrode holders and their working mechanism are mounted on the boiler plate, and the furnace is built on this. The electrode holders are aluminum bronze castings and are moved to and fro by means of right- and left-handed screws respectively. The shaft of each screw terminates in a gear engaging with gears mounted on a shaft which passes under the boiler plate base and which has a hand wheel mounted at one end. By this hand wheel one worker can attend to the running of the furnace. The hand wheel shaft is in two parts connected with a coupling and near this is a small collar on the shaft. This arrangement is used to form what we call a "gear lock," which consists of an iron bar held between the collar and the coupling. This bar is hinged and can be dropped down so that the hand wheel shaft may be pushed longitudinally in its bearings sufficiently far to throw the gears out of mesh.

*Paper read at the meeting of the American Electrochemical Society in Chicago, Sept. 23-26, 1919.

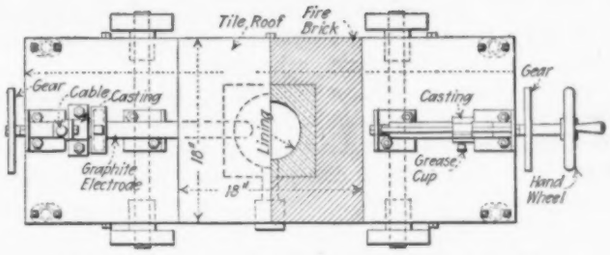


FIG. 3. PLAN OF A SECTION OF FURNACE

This allows the electrode holders to be separately adjusted when desired. The water-cooling rings are bronze castings and slide on the electrodes. They are hollow and open at the top so that they can be kept filled with water, thus cooling the electrodes. The rings should not be in the position shown in the drawing, but should be pushed up close to where the electrodes pass through the furnace walls.

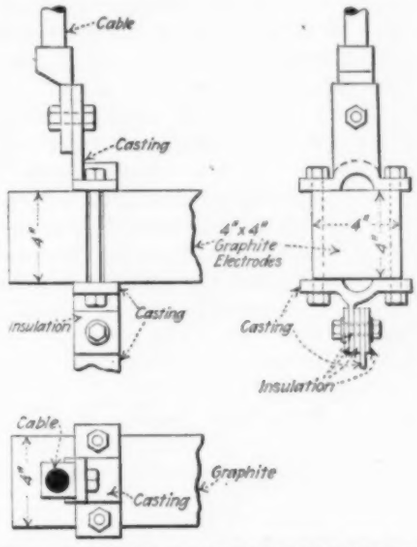


FIG. 4. DETAILS OF ELECTRODE HOLDERS

As shown in the drawing, the furnace is built up so as to heat the charge in the crucible by radiation from the arc. In our work we generally use a current at 50 volts and 500 to 1000 amperes.

The apparatus can also be used for other kinds of furnaces; for example, for heating a crucible embedded in granular carbon. When used in this way convenient electrodes are 4 x 4 in. (10 x 10 cm.) graphitized carbons. Fig. 4, besides showing details of the electrode holder construction, shows modification for use with 4 x 4 in. carbons. The mobility of the electrodes permits of considerable variation in the resistance of the furnace while running with a granular carbon resistor.

The furnace also is convenient for heating the central portion of a horizontal tube embedded in a granular carbon resistor, and, of course,

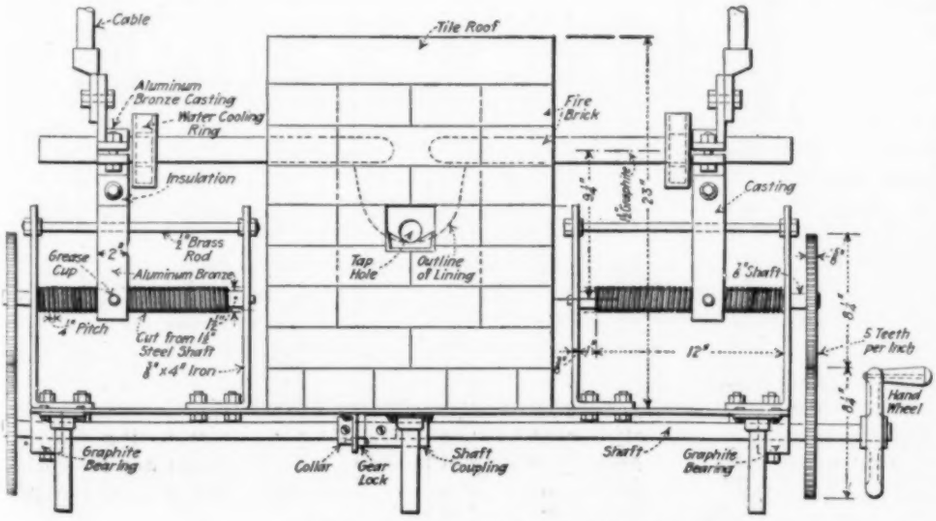


FIG. 2. SIDE VIEW OF FURNACE

it may also be used as a furnace in which the tube is heated by an arc on the outside, but in this case the 1½-in. (3.8-cm.) electrodes are used.

While there is nothing original in the general principles of the furnace, it is believed that the detail design may be found as useful by others as it has by us, on account of its being so cheap and easy to construct.

FitzGerald Laboratories,
Niagara Falls, N. Y.

Experience With a 91:9 Copper-Aluminum Alloy

BY A. I. KRYNITZKY*

AFTER many experiments in the foundry of the Time Fuse Plant in Petrograd, Russia, with different copper-aluminum alloys it was decided to use an alloy containing about 9 per cent of aluminum. It might be stated in advance that with 10 per cent aluminum or more it is very difficult to obtain a homogeneous alloy, particularly with a single melting. In most cases the fracture shows a liquation and also a coarse crystalline structure.

Referring to the equilibrium diagram, these alloys—9 to 10 per cent of aluminum—are very close to the point a_1 (see Fig. 1). We have to expect here the presence of homogeneous alpha solution in the case of annealed alloys containing 9 per cent or less of aluminum; and in the case of 10 per cent or more aluminum, secondary alpha crystals within the primary beta, and also alpha and gamma crystals within original grains of beta.

*Formerly chief inspector of time fuses for the Russian Government in the United States; now assistant physicist, Bureau of Standards, Washington, D. C.

Concerning the process of casting, in the first place a well known fact was confirmed, that the temperature of the casting is of great importance. The alloy must be poured at a temperature very near its melting point, which in the absence of a pyrometer is difficult to get because of the formation of a thin film, which makes observation difficult. Chill casting is better than sand casting.

PURITY OF RAW MATERIAL IMPORTANT

The purity of the raw material is, as usual, very important. This fact was confirmed in these experiments with four kinds of copper used: Mansfeld copper, Bare, Tamarack and a Chinese brand. While uniformly good results were obtained with the first three kinds of copper, the last one gave very bad results; it contained a relatively large amount of oxygen.

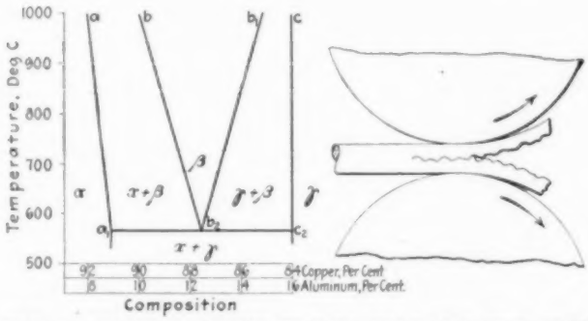


FIG. 1. PART OF EQUILIBRIUM DIAGRAM FOR COPPER-ALUMINUM ALLOYS, FROM G. H. GULLIVER. FIG. 2. SKETCH SHOWING NATURE OF BREAK IN SPLIT RODS

There was no opportunity to compare different kinds of aluminum, as only one kind was used: aluminum of Neuhausen, Switzerland. Analysis of the above-men-

TABLE I.

Per Cent of Aluminum in Alloy	Lot No.	Method of Casting	Final Annealing	Diameter of Cast Bars, Inches	Final Diameter of Finished Bars, Inches	Mechanical Properties on Tension					
						Yield Point		Ultimate Strength		Elongation for 72 Mm., Per Cent.	Reduction of Area $\frac{S-s}{S}$ Per Cent.
						Kg. per Sq. Cm.	Lb. per Sq. In.	Kg. per Sq. Cm.	Lb. per Sq. In.		
10	1	Chill cast	None	1.125	0.570	.....	.....	2,770	39,398	6.9	.....
10	2	Same	None	1.125	0.570	4,087	58,130	5,073	72,154	12.5	.....
10	3	Same	None	1.125	0.570	3,768	53,593	5,283	75,142	13.5	.....
10	4	Same	Was done	1.125	0.570	5,386	76,606	6,379	90,729	36.9	.....
9	5	Sand cast—dry sand	None	1.100	0.570	5,500	78,228	5,856	83,291	20.2	.....
9	6	Same	None	1.100	0.570	4,869	69,253	5,799	82,480	23.5	.....
9	7	Sand cast—green mold	None	1.100	0.570	.....	.....	3,183	45,272	3.8	.....
9	8	Sand cast—dry sand	None	1.100	0.570	4,096	58,258	6,175	87,827	25.2	.....
			Was done	1.100	0.570	4,010	57,035	6,366	90,544	30.1	.....
9	9	Same	None	1.100	0.570	5,131	72,978	5,870	83,489	24.4	.....
9	10	Same	None	1.100	0.570	5,054	71,884	5,870	83,489	33.3	.....
9	11	Same	None	1.100	0.570	5,092	72,424	5,730	81,498	35.8	.....
9	12	Same	None	1.100	0.570	4,678	66,536	5,462	77,686	31.7	.....
9	13	Same	None	1.100	0.570	4,073	57,931	5,366	76,321	46.7	.....
9	14	Same	None	1.100	0.570	4,456	63,378	5,563	79,124	43.8	.....
9	15	Same	None	1.500	0.750	.....	.....	5,283	75,141	21.8	.....
9	17	Same	None	1.500	0.750	3,819	54,318	5,391	76,677	41.1	.....
10	21	Sand cast—dry sand without mechanical work	None	1.600	1.600	4,583	65,184	5,131	72,978	14.0	.....
9	22	Chill cast	None	1.250	0.750	5,697	81,029	6,239	88,739	38.7	.....
9	23	Same	None	1.250	0.750	5,697	81,029	7,282	103,576	12.9	.....
9	24	Sand cast—dry sand:									
		(a) Low forging	None	1.600	0.750	5,793	82,394	6,009	85,467	18.6	.....
		(b) Medium forging	None	1.600	0.750	6,332	90,061	6,421	91,326	20.4	.....
		(c) Great forging	None	1.600	0.750	.....	.....	6,810	96,860	21.2	.....
9	25	Chill cast	None	1.250	0.750	5,517	78,469	5,953	84,670	29.0	.....
9	26	Same	None	1.250	0.750	5,262	74,843	5,984	85,112	39.0	.....
9	27	Sand cast—dry sand	None	1.600	1.240	6,028	85,737	6,282	89,350	24.1	.....
9	28	Same	None	1.600	0.750	6,221	88,483	6,408	91,142	21.3	.....
9	29	Chill cast	None	1.250	0.750	4,349	61,857	5,598	79,622	39.3	.....
9	30	Chill cast	None	1.250	0.750	7,214	102,609	7,325	104,186	16.9	.....
9	31	Chill cast	None	1.250	0.750	7,670	109,096	7,767	110,473	13.7	.....
			Was done	1.250	0.750	3,647	51,871	6,149	87,458	32.1	.....
9	32	Same	None	1.250	0.680	7,129	101,392	7,312	104,001	14.7	.....
9	33	Same	None	1.250	0.680	6,684	95,068	7,079	100,686	17.6	25.6
9	34	Chill cast and quenched in cool water	None	1.250	1.250	2,896	41,190	4,233	60,206	16.3	24.1
		Chill cast and slow cooled	None	1.250	1.250	2,896	41,190	5,634	80,134	29.1	30.9
		Chill cast	None	1.250	0.680	5,730	81,499	6,989	99,406	29.2	38.1
		Chill cast	Was done	1.250	0.680	4,551	64,729	7,136	101,492	.....	31.5

tioned first three kinds of copper showed very close to 99.6 per cent copper. Analyses of the aluminum were very close to Al 98.81 per cent, Si 0.45 per cent, Fe 0.44 per cent.

All work was done under manufacturing conditions. The alloy was melted and cast in the ingots and then remelted (sometimes more than once) in crucibles, in an oil-fired furnace, a thin layer of charcoal being used to cover the charges to prevent oxidation. For stirring the melts graphite rods were used exclusively.

As before noted, the use of an alloy with 10 per cent or more aluminum is not recommended, since such an

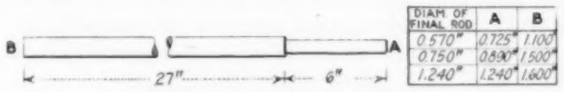


FIG. 3. SAND-CAST BARS

alloy requires too many precautions in its manufacture. From our experience it was found that in most cases the cast rods had many blow-holes and contained along the axis a material which showed up very definitely in cross-section as a gold band against the gray-white background of the alloy.

Fracture During Rolling

High aluminum rods during cold rolling were easily split in two parts, the fracture very often showing almost regular teeth, as in Fig. 2. Also in case some good rods could not stand more or less severe cold roll-

FIG. 4. CHILL-CAST BARS

ing, they in most cases were broken in a similar manner.

It is important to note that this phenomenon has never occurred (at least in the writer's practice) with other alloys, such as different kinds of brasses, bronzes, aluminum alloys, etc. The explanation we have to seek in the structure of the alloy.

Rolling and Drawing

The cast rods were cropped off, the skin removed by forcing through sharp dies, they were then annealed, cold rolled and drawn, annealing being applied between

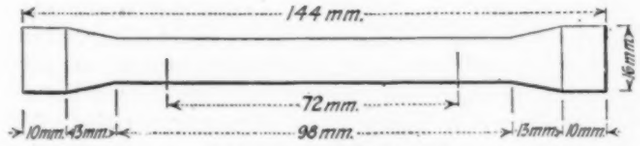


FIG. 5. TEST BARS

passes. The skin was removed also before drawing, and, besides, sometimes between some draws.

Fig. 3 shows the dimensions of sand castings, corresponding to finished bars of various diameters.

Fig. 4 shows chilled castings which correspond to the finished bars of final diameters 0.570, 0.680 and 0.750 in.

Tensile Tests

Lots Nos. 1, 2, 3, 4 and 21 contained about 10 per cent of aluminum; the rest of the lots were cast of an alloy containing about 9 per cent of aluminum. Several test bars (see Fig. 5) were taken from every lot and were pulled on a Mohr and Federhaft machine. The averages of these results are given in Table I.

As to lot No. 21, which was subjected to high, medium and low forging; the difference in the degree of forging was attained by first removing different amounts of skin by means of a sharp die. The less skin removed, the greater the forging subsequently applied.

Concerning lot No. 34 it should be noted that metal cast and quenched immediately in cold water shows less ductility and tensile strength than the same cast when slowly cooled.

To the writer's regret this work, because of circumstances, was discontinued and no more data were obtained. Therefore no positive conclusion can be drawn as to the nature of the peculiarities appearing. Referring to the equilibrium diagram (Fig. 1) it might be said, however, that in both cases (rapid quenching in cold water and slow cooling) we would expect to get only the alpha solution.

Cone Shaped Fracture

Some of the rolled bars 1.240 in. in diameter were experimented with for the manufacture of primers. The bars were cut into cylinders and cold pressed in a hydraulic press, the faces being perpendicular to the axis. Sometimes the cylinders could not withstand the pressure and were consequently broken, always in a characteristic way, a cone shaped piece coming out of the top, as shown in Fig. 6.

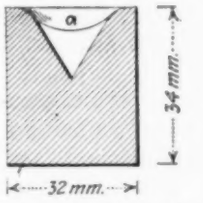


FIG. 6. SECTION OF PIECES WHICH FAILED UNDER COMPRESSION

Attention is called to this fact in connection with the breaking of rods during cold rolling, as was previously illustrated in Fig. 2. This phenomenon reminds one of the fracture of malleable cast iron under pressure.

Machining

Machining these alloys is not difficult. Small pieces, of course, will crack if not machined at medium speed, with good tools and with a cooling solution.

Washington, D. C.

Glauber's Salt in Siberian Lakes

The following is an estimate of supplies of precipitated Glauber's salt in some of the Siberian lakes: (1) The Great Marmyshansk Lake—144,000,000 poods (2,600,000 short tons) of crystalline salt ($Na_2SO_4 10H_2O$) and 22,000,000 poods (397,210 short tons) of evaporated Glauber's salt; (2) Little Marmyshansk Lake—25,000,000 poods (451,400 short tons) of crystalline salt; (3) Lake Tuskal (Minusinsk district)—up to 100,000,000 poods (1,805,500 tons) of crystalline salt; (4) Lake Varche (Minusinsk district)—up to 100,000,000 poods (1,805,500 tons) of precipated crystalline salt and an enormous quantity of Glauber's salt in solution.

Samples Exhibition to Be Held at Trieste

Consul O'Hara cables from Trieste that an announcement has been made of a permanent samples exhibition to be held at Trieste under the auspices of the Chamber of Commerce. A special building will be erected for the purpose, which is expected to be ready by next summer. The consul considers this an excellent opportunity for American exporters to display their goods.

Electrical Treatment of Sewage—Landreth Process*

SEVERAL electrolytic methods have been suggested for the purification of sewage. The first to be experimented with, the invention of Webster, was installed at Corness, England, in 1889. In this process the raw sewage flowed in contact with iron electrodes through long troughs; a current of 0.9 amp. was maintained by an e.m.f. of about 2 volts. For treating raw sewage the estimated consumption was 240 lb. of iron and 450 kw.-hr. per million gal. In this process the oxygen liberated at the anode was mostly consumed in oxidizing the iron electrodes; the oxides thus formed acted as a precipitating agent for the sludge of the sewage; the process was therefore chemical rather than electrical. The second process to be experimented with attempted disinfection by means of nascent chlorine liberated by the electrolysis of a soluble chloride. In the earlier installations a chloride was mixed with the sewage and the solution electrolyzed; later sodium hypochlorite produced electrolytically was added to the sewage. In 1893, at Brewster, N. Y., this latter method was used under the direction of the New York City Health Department. About 1600 lb. of salt was used per million gal. and the plant required 700 amp. at 5 volts.

Kennicut, Winslow and Pratt[1] summarize the electrolytic methods of treatment so far developed as being a question of the cost of supplying the disinfectants and precipitants needed; usually this cost is not in favor of electrolysis in the presence of sewage.

The failure of sedimentation thoroughly to clarify sewage led to the introduction of the chemical precipitation method, and lime was the first precipitant to be used. This method is open to the objection that the addition of too much lime renders varying amounts of the suspended organic matter soluble, which causes the effluent to be more putrescent and obnoxious than that from ordinary sedimentation.

The Landreth Direct Oxidation Process

In the Landreth direct oxidation process for the treatment of sewage, both electricity and lime are employed. The efficiency of the process depends on the combination of these two agents; neither alone produces as good results. Oxygen and hydrogen liberated at the electrodes in the nascent state are claimed to promote the destruction of pathogenic bacteria, also to reduce nitrogenous matter to nitrites, nitrates and carbon dioxide. The presence of lime furnishes an alkaline medium and renders the electrodes passive, thereby reducing the amount of iron going into solution; the lime also assists sedimentation. This process was extensively studied at a 750,000-gal. plant at Elmhurst, L. I., in 1915, later at Decatur, Ill. During the spring of 1918 a million-gal. plant was constructed at Easton, Pa., by Mr. Landreth for demonstration purposes.

Description of Process

The raw sewage upon entering the plant passes through a coarse screen over a screen having six 0.25-in. holes per sq.in., is then elevated by a centrifugal pump passing over a measuring weir to the electrolytic tanks, then through an observation flume and is discharged either through a sedimentation tank or direct to the river.

The electrolytic apparatus consists of a horizontal cypress box 27 ft. 3 in. long, 3 ft. wide and 2 ft. 9 in. deep. The removable top is constructed in two sections and can be made watertight by means of bolts and rubber gaskets. Each section of the top is vented for the removal of the gaseous products of electrolysis. A series of valves at the bottom of the tank serves for the removal of sludge.

Internally the tank is divided into eleven spaces, each of which contains two banks of electrodes mounted one above the other, giving a total of 22 banks of electrodes arranged in two horizontal rows of eleven each. These banks of electrodes, each of which consists of 48 plates of mild steel 10 in. by 16 in. by $\frac{3}{16}$ in. spaced $\frac{3}{8}$ in. apart, are placed across the box, the plates being vertical and parallel to the sides. The 48 plates of each bank are electrically connected so that alternate plates have the same polarity, the 22 banks being connected in series. The tank is so constructed that the entire flow of sewage is through the $\frac{3}{8}$ in. spaces between electrodes. Paddles revolve in each of the spaces between electrodes at 20 r.p.m. The total electrode area is 124,287 sq.in.

Description of Operations

Milk of lime is added at the measuring weir by an apparatus which permits of close regulation, and the amount added is sufficient to give about 30 p.p.m. excess CaO in the effluent. The polarity of the electrodes is changed at regular intervals to reduce polarization. Calcium carbonate tends to crystallize on the electrodes and has the effect of increasing the power required by the stirrers; whenever the power consumption reaches 2000 watts the addition of lime is discontinued. The acid in the raw sewage dissolves these crystals, reducing the power consumption to normal, or to about 1100 watts, when lime is added again at the inlet of the tanks. During this operation lime is added at the observation weir. The voltage of the individual cells ranges from 2.5 to 3.7 volts, averaging 2.82 volts with a current of 34 amp.

Efficiency and Costs

The efficiency of any method of sewage treatment cannot well be shown by a tabulation of results, due to the large variation of the raw sewage and to the means of disposal of the effluent; these are determined by local conditions. It is usual to design a plant to meet these conditions. The amount of dissolved oxygen absorbed by an effluent is an important standard; the effluent from the Landreth process is below the most stringent standard in this respect. The average absorption of dissolved oxygen upon standing five days was 0.77 p.p.m., whereas the very strict standard of the Royal Commission on Sewage Disposal allows 30 p.p.m. as a maximum. The effluent produced by the Landreth process is considered highly satisfactory.

A million-gal. plant would consume power at the rate of 335 kw. and 90 per cent lime at the rate of 800 lb. per million gal. A typical plant for treating sewage from a town of 55,000 population can be operated at a cost of 64c. per capita. An "activated sludge" plant would cost $1.10 and an "Imhoff-trickling filter" plant 82c. per capita. A Landreth plant has the additional advantage that it requires only a small ground area and can be operated and installed in a thickly populated district without being offensive.

*Abstract, *J. Frank. Inst.*, vol. 188, No. 2, p. 157.

[1]Kennicut, L. P., Winslow, C. E. A., and Pratt, R. W.: "Sewage Disposal," 1919, John Wiley & Sons, New York.

Effect of Surface Tension on Crystalline Form*

By Cecil H. Desch
Professor of Metallurgy in the Royal Technical College, Glasgow

THE investigation which forms the subject of these reports was undertaken at the instigation of Sir George Beilby to test the hypothesis of Quincke, according to which metals and other substances, immediately before solidification from the liquid state, separate into two immiscible liquids, one of which is formed in much smaller quantity than the other. These liquids have an interfacial surface tension, and a foam is formed, the liquid present in smaller proportion arranging itself in cell walls, and the second constituting the cell contents. Crystallization then takes place within the foam cells, and the cell walls are represented in the solid mass by the boundaries of the crystal grains.

If this were actually the case, the form of the crystal grains in a solid metal might be expected to approximate to that of the cells in a foam, such as is produced by blowing air through a soap solution, the shape of the cell walls in both cases being due to surface tension. The subsequent growth of the crystals forming the cell contents might distort the original cells, but could scarcely produce a complete change of type.

Theoretical Form of Foam Cells

The problem of the form of individual cells in a foam has received surprisingly little attention. The fundamental principles were established by Plateau in his classical investigations,[1] and may be stated as follows:

(*a*) Only three films can meet in an edge, and they must make equal angles of 120 deg. with each other;

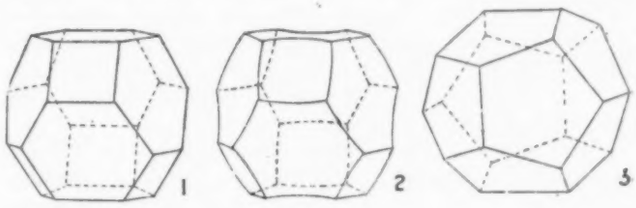
(*b*) Only six films can meet at a point, and adjacent edges must make equal angles of 109 deg. 28 min. with one another.

The foam being the result of surface tension, the area of each cell is necessarily a minimum for the given conditions. The arrangement of the dividing walls in a single layer of bubbles on the plane surface of a liquid is easily shown to be a regular hexagonal pattern.

The beautiful experiments of Plateau did not include the examination of a mass of foam. A solution of this problem was obtained by Lord Kelvin.[2] The most general solution for the homogeneous division of space was shown by him to be a tetrakaidecahedronal cell, consisting of fourteen walls, which may be plane or not plane (Figs. 1 and 2). Eight of these are hexagonal and four quadrilateral, so that there are thirty-six edges and twenty-four corners. Each face is common to two neighboring cells; each edge is common to three cells, and each corner is common to four cells. Any homogeneous assemblage of similarly shaped and similarly oriented objects, however irregularly shaped, may be divided from one another by similar cells of the above type, in such a way that every single object is completely inclosed in one cell. The simplest example of such a cell may be obtained by truncating the six corners of a regular octahedron to such a depth that the eight original triangular faces are reduced to equilateral equi-angular hexagons.

Foam cells are subject to the further condition that the partitional area must be a minimum. The tetrakaidecahedron of minimum area has been shown[3] to have also eight hexagonal and six quadrilateral faces, all the edges being equal in length; but the latter, instead of being straight lines, are now similar plane arcs. The condition being that the edges must meet at an angle of 109 deg. 28 min., each arc is one of 19 deg. 28 min. It is not actually circular, but may be considered as such without serious error. The figure may be constructed very simply by stiff brass wires soldered together to form the required figure. Such a wire model, immersed in soap solution, gives a giant foam cell, the faces of which have the required form. The hexagonal films are doubly curved in such a way that the three diagonals are straight lines lying in one plane, and the sum of the curvatures in mutually perpendicular normal sections at any point is constant. A mass of foam built up of similar cells of the above shape would be stable.

The rhombic dodecahedron, Fig. 8, is a plane-sided polyhedron, of which each pair of sides meets at an angle of 120 deg., and space may be filled with equal and similar rhombic dodecahedra. Moreover, it is the only plane-sided polyhedron which fulfills these conditions, but foam cells of this form are unstable, since it involves the meeting of twelve plane films at a point, an unstable equilibrium which may be departed from in three different ways.



FIGS. 1 TO 3

Fig. 1—Tetrakaidecahedron with plane faces. Fig. 2—Tetrakaidecahedron of minimum area. Fig. 3—Regular pentagonal dodecahedron.

Experimental Examination of Foam Cells

In order to prepare a foam, some solution is poured into a glass trough with plane parallel sides, and air is blown through it by means of a narrow pipette until the trough is filled with foam. When a fairly stable condition has been reached, single cells are examined by placing the trough in front of a window, screening it with a sheet of black paper having a hole about 2 cm. in diameter, so that the attention is more easily concentrated on a single cell. An attempt is then made to count the cell walls, and to record the number of edges of each face. This is done for as many cells as possible. The direction of curvature of the walls may often be recognized by the arrangement of the bands of color under illumination. A second method consists in making a foam from a warm solution of gelatin, of sufficient concentration to set on cooling. The foam cells are thus fixed, and may be examined at leisure, each cell being cut open and examined in turn by using fine-pointed dissecting scissors. Both methods have been employed in obtaining the results shown below.

*Second report (slightly condensed) to the Beilby Prize committee of the Institute of Metals on the solidification of metals from the liquid state, presented Sept. 24, 1919. The first was presented to the Institute at the spring meeting of 1914, and consisted of a review of the state of knowledge respecting the solidification of metals from the liquid state.

[1] J. Plateau, Statique expérimentale et théorique des liquides. 2 vols. Ghent, 1873.

[2] *Proceedings* of the Royal Society, 1894, vol. 55, p. 1; Collected Papers, vol. 5, p. 333.

[3] *Philosophical Magazine*, 1887, vol. 24, p. 503; Collected Papers, vol. 5, p. 297.

The forms of the cells were found to be essentially the same in all cases.

Even a casual examination of a mass of foam shows that the individual cells vary in form, but however irregular they may appear, it is easily seen that the faces and edges fulfill the conditions established by Plateau. Occasionally, when movements are in progress in the midst of the mass, four films may be seen to meet in one edge, but the position is unstable, and sliding immediately takes place until equilibrium is reached. The vertices of large cells are often truncated, and a small cell is then interposed between the larger neighbors. Such transitional cells are either hexahedra, elongated in one direction, and having the edges slightly curved so as to make angles of 109 deg. 28 min. with one another instead of 90 deg., or tetrahedra, the edges of which must be strongly curved.

TABLE I—STRUCTURE OF FOAMS

Material	Average Number of Faces to Each Cell	Number of Sides to a Face 3	4	5	6	7	8
Plateau's solution	13	2	52	128	57	18	..
Ammonium oleate	13	1	54	130	64	10	..
Soap solution	..	3	23	39	18	..	..
Soap solution	..	4	36	87	53	12	2
Gelatin	10.5	..	18	36	6	3	..
Gelatin	10	1	10	26	13	1	2
Gelatin	9	2	18	20	6	1	..
Gelatin	11	8	41	46	35	6	..
Gelatin	..	..	16	40	17	..	..
Totals		21	268	552	269	51	4

(The first two preparations, in which the largest number of cells was counted, were the most regular in structure. Some cells proved to be complete pentagonal dodecahedra. The gelatin preparations, no doubt owing to viscosity, were the most variable.)

The results of observations of several masses of foam, prepared at different times and by different methods, are given in Table I. It is at first sight surprising that an approximation of Lord Kelvin's tetrakaidecahedron should be so rare. If this were the usual type of cell, four- and six-sided cell walls would occur with frequencies in the ratio of 6 to 8, but the observations show that five-sided faces are much more common than either, and that hexagonal faces are comparatively infrequent. The cells often approach very closely to the form of a regular pentagonal dodecahedron (Fig. 3). This figure has faces with five equal angles of 108 deg., thus coming very near to the required angle of 109 deg. 28 min., and adjacent faces meet at an angle not far from the equilibrium value of 120 deg. A slight curvature of the edges therefore converts the pentagonal dodecahedron into a possible figure of equilibrium for a foam cell.

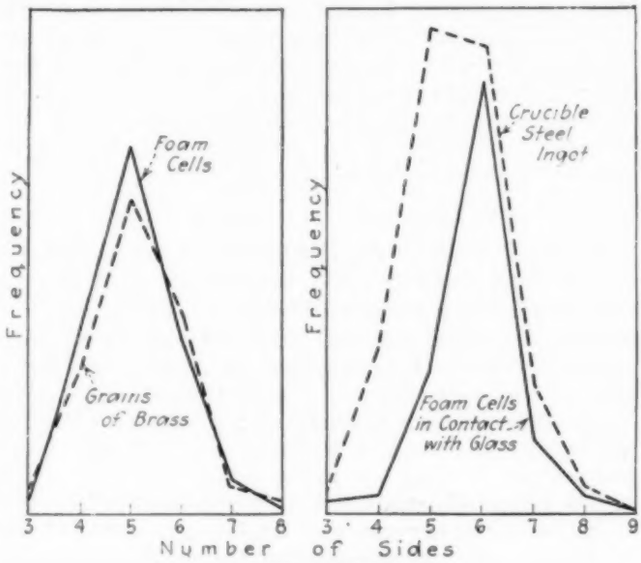
Experimental Examination of Crystal Grains

The next step is to examine the forms of crystal grains in cast metals, and to determine how far they correspond with those of foam cells. For this purpose advantage was taken of a fact mentioned by Professor Huntington in the discussion on the previous report,[4] that β-brasses containing aluminum, when immersed in mercury, separate into distinct grains, the mercury penetrating between the grain boundaries. A suitable mass of metal was available, and the coarse grains thus isolated had a brilliant, silvery surface, owing to amalgamation. They could be examined under a hand lens, each face being marked with a dot of ink after noting the number of its sides and the direction of its curvature. The results of the examination of thirty of these grains are shown in Table II. The number of faces is usually large, varying from 11 to 20, with an average of 14.5. Generally speaking, the larger grains are the more complex. The faces are mostly curved, and double curvature, recalling that of foam cell walls, is frequent. It will be seen that there is a great preponderance of pentagonal faces. The figures are plotted in Fig. 4 for comparison with those given by the counting of cells in soap and gelatin foams, and the general resemblance of the two curves will be noticed.

Attempts have also been made to separate other metals in the same way, but the number available was small, and it was not thought worth while to present the figures separately.

Effect of Superfices

The preceding remarks concerning the forms of foam cells and crystal grains are applicable only to cells which occur in the midst of a large mass, and are therefore independent of boundary condition. Where the wall of a foam cell meets a solid surface, such as the glass of the containing vessel, it does so at an angle of 90 deg. The partitioning of neighboring cells is still subject to the condition that only three walls can meet at an edge, and that the angle between them must be 120 deg. The most natural arrangement then becomes a regular hexagonal pattern. Actually, as the cells very in size, polygons having a variable number of sides are observed, but the hexagonal form predominates. Figures for soap and gelatin films are given in Table III, and are represented graphically in Fig. 5.



FIGS. 4 AND 5

Left—Shape of brass grains compared to foam cells. Right—Shape of boundary grains of ingot compared to foam cells.

TABLE II—GRAINS IN PROPELLER BRASS IN β-CONDITION

Material	Average Number of Faces to Each Grain	Number of Sides to a Face 3	4	5	6	7	8
β-brass	14.5	11	88	190	123	20	3

A convenient metallic object for comparison was a small ingot of crucible steel, the fracture of which showed dendritic crystals extending from the four surfaces to the center of the ingot. One of the outer faces was polished and etched, so giving a transverse section of the dendritic crystals close to their origin.

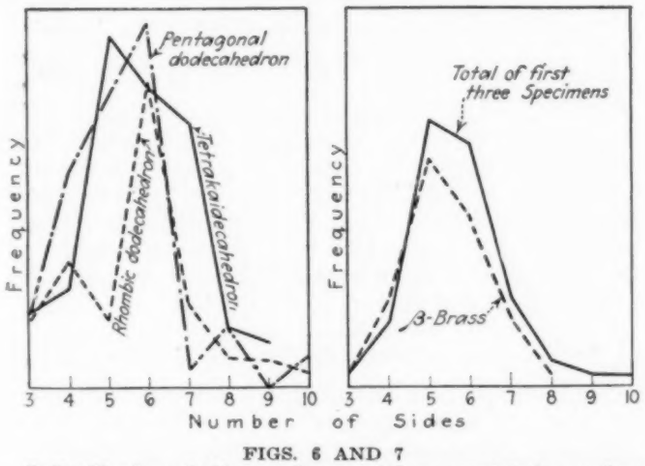
[4] *Journal* of the Institute of Metals, No. 1, 1914, vol. 11, p. 108.

The polygonal outlines thus exposed were examined as above and the results are shown in Table IV and Fig. 5. Some of the grains were very complex, and it is probable that a certain amount of coalescence takes place between neighboring dendrites, giving rise to compound grains, the outlines of which are more or less irregular.

While it has only been found practicable to examine isolated crystal grains in exceptional cases, it is always possible to make plane sections through the metal, and to examine the shape of the grain boundaries exposed in that section by etching. Such boundaries often have a simple polygonal form, and it would appear at first sight that it should be possible, by counting the sides of a sufficiently large number of polygons, to infer from the result the probable form of the polyhedra of which they are the sections, provided that those polyhedra are either similar or vary closely about a mean type. Unfortunately, the problem of establishing a relation between the form of a polyhedron and that of its plane sections proves to be peculiarly difficult. The mathematical problem on which the solution depends may be stated simply. It is: given the form of a polyhedron, what is the probability that a plane section, drawn through it at random, will have 3, 4, 5, . . . n sides? A general solution, even for a simple case, such as a cube, does not appear possible. One is therefore reduced to some geometrical expedient.

A rough experimental method has been adopted, models of the polyhedra being made in cardboard, and rendered waterproof. By immersing these, plane sections are realized by the intersections of the model, placed in various positions, with the surface of the water. Placing the model with a selected line vertical, it is immersed by successive equal steps, such as 1 cm., and the form of the intersection is noted at each step. Experiments of this kind have been made with models of the rhombic dodecahedron, pentagonal dodecahedron, and orthic tetrakaidecahedron.

As an illustration of the method adopted, the first of these solids may be taken. The model may be immersed with one face horizontal. The height of the model employed being 13 cm., 14 sections at distances of 1 cm. are obtained, of which 8 are four-sided and 6 are six-sided. As there are 12 rhombic faces, to any one of which the section might be parallel, these numbers must be multiplied by 12. Similarly, any one of the 24 edges might be placed horizontally, like the ridge of a roof, or a vertex might be placed uppermost, there being 8 trihedral and 6 tetrahedral vertices. A vertex being tilted to one side, a fresh set of observations is made, and so on. The curve drawn in Fig. 6 represents the relative frequency with which each section occurs, a total of 1732 sections having been used for its construction. The curves for the other polyhedra have been constructed in the same way.



FIGS. 6 AND 7

Left—Number of sides on figure cut from crystals by random planes. Right—Shape of crystal intersections in metallographic prints.

There is no certainty that sections thus arbitrarily chosen will be distributed in the same way as those found at random, but the number taken is large, and it seems worth while to test it. Small errors may also be introduced by accidental irregularities in the models. The metal specimens used for comparison with the above figures included the same brasses which had furnished the isolated grains, two pieces of very mild steel, having polygonal grains with remarkably straight boundaries, and several miscellaneous specimens which were used for purposes of comparison. The results are shown in Table V, and are represented graphically in Fig. 7.

An examination of the tables and curves makes it evident that little information is to be gained from a study of the cross sections of crystal grains, at least until greater certainty can be reached as to the relation between the form of a polyhedron and the probability that a section cut through it at random will have a given number of sides. If the curves shown in Fig. 6 represent anything like the proper distribution, it would be difficult, if not impossible, to infer which was the true form of the polyhedron approaching most nearly to the average crystal grain, as the distribution is not sufficiently characteristic.

TABLE III—CELLS IN CONTACT WITH GLASS

Material	Number of Sides to a Cell 3	4	5	6	7	8	9
Soap solution	1	8	12	55	15	3	..
Soap solution	8	10	55	100	28	7	..
Gelatin	..	1	17	22	2	3	1
Totals	9	19	84	177	45	13	1

TABLE IV—GRAIN BOUNDARIES AT COOLING SURFACE OF INGOT

Material	Number of Sides to a Cell 3	4	5	6	7	8	9
Crucible steel	5	44	93	93	27	6	1
Crucible steel	3	44	135	126	32	2	..
Totals	8	88	228	219	59	8	1

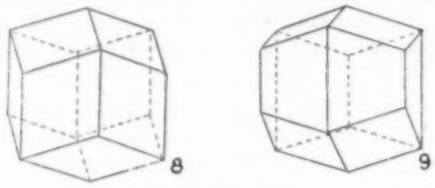
TABLE V—CRYSTAL GRAINS SEEN IN PLANE SECTIONS

Material	Number of Sides to a Grain 3	4	5	6	7	8	Over 8
Mild steel rod	5	61	299	245	93	16	7
Mild steel casting	4	17	67	64	7	..	..
Propeller brass	9	24	57	70	36	18	6
β-brass ingot	9	50	137	102	43	6	..

Assumption of Equidistant Nuclei

If we suppose that surface tension has nothing to do with the form of the crystal grains, but that these are determined solely by growth from centers, a conclusion may be reached as to the form to which such grains should approximate. It seems likely that in a sufficiently large mass the nuclei should be approximately equidistant. This would be equivalent to the close packing of a large number of spheres. It is known that such close packing may take place in one of two ways, known respectively as the cubic and the hexagonal. If we imagine closely packed spheres to be made of some deformable substance, such as plasticine, and pressure to be then

applied so as to close up the interstices, a mass of polyhedra will result. Cubic packing leads to the formation of regular rhombic dodecahedra, and hexagonal packing to that of dodecahedra which have certain of their faces no longer rhombs, although still quadrangular. (See Figs. 8 and 9.[5]) Whichever were formed, the grains would have quadrangular faces, and in a mass of metal solidifying under such conditions the grains might be expected to show a preponderance of 4-sided faces. This is not confirmed by the observation of grains isolated by the mercury method. If, however, the form of the grains were determined by surface tension, they might be expected to approach more closely to the pentagonal



FIGS. 8 AND 9

Fig. 8—Rhombic dodecahedron from cubic packing. Fig. 9—Dodecahedron from hexagonal packing.

dodecahedron, or to the tetrakaidecahedron, or to some compromise between the two. This is confirmed by the results shown in Fig. 4, there being a marked preponderance of faces with 5 edges, followed by 6 and 4.

Relation Between Directional Impulse and Surface Tension

There is thus evidence that the forms of the crystal grains in at least some metals are such as might be expected if surface tension were concerned in their determination. On the other hand, it is well known that many crystal grains are less simple, and exhibit complex interlocking. There is a striking difference between α- and β-brasses in this respect. α-brasses usually have interlocking boundaries, and rarely approach simple polyhedral forms. Iron and steel may form either polyhedra or interlocking grains, according to circumstances. One is forced to the conclusion, previously expressed by the writer,[6] that two forces are competing in the formation of crystals. One is the directive force of cohesion, sometimes called the crystallizing force, and the other is surface tension. The ratio which the one bears to the other varies with the nature of the crystalline substance, the temperature of crystallization, the composition of the mother liquor, and the absolute dimensions of the mass of the solid. When the mass is very small, so that the surface is large relatively to the volume, the surface forces may be so great as to mask the crystallizing tendencies completely. This aspect of the subject has been specially studied by Sir George Beilby.[7] With larger masses the other factors become more important, and the specific differences between different metals become particularly noticeable. It will be seen, however, that a metal which has a great power of orientation will be likely to form interlocking grains, as the boundaries will be chiefly determined by the growth of the crystallites, while a second metal, in which the orienting forces are weaker relatively to the surface forces, will tend to form grains of a simpler character, surface tension intervening to check the growth.

Reference may here be made to one case in which an isolation of crystal grains has been effected, but in which only complex forms have been observed. This is the case of glacier ice, the crystals of which have not been formed directly from the liquid state, but re-formed from the original minute snow crystals by successive partial fusion and regelation under the influence of non-uniform pressure. The action of sunlight sometimes causes a mass of glacier ice to disintegrate into grains, which are readily separated from one another. These grains do not appear to be of simple form, but interlock in a complex fashion. "The shape of the grains is irregular, and no two of them are alike, but they fit into each other like a puzzle. They resemble a collection of vertebræ more than anything else."[8] It is not proved that such disarticulated masses, which vary in size in a single mass of glacier ice from ½ to 700 g., are actually single crystal grains, and it may well be that they are aggregates of smaller units, but they are differentiated from the general mass by the ready fusion of the thin sheath of eutectic surrounding them, so that sunlight etches the outline of the grains on the inner surface of a grotto, revealing interlocking boundaries curiously resembling the sutures of the cranial bones.[9] It is quite possible that two orders of cellular structure are here present, this being a feature common to many solidified masses, both metallic and non-metallic.

[5]W. Barlow and W. J. Pope, *Transactions* of the Chemical Society, 1907, vol. 91, p. 1158.

[6]*Proceedings* of the Royal Philosophical Society of Glasgow, 1912, vol. 43, p. 114.

[7]*Proceedings* of the Royal Society, 1903, vol. 72, p. 226.

[8]J. Y. Buchanan, *Antarctic Manual*, 1901; Comptes Rendus of Observation and Reasoning, p. 48. Cambridge, 1917.

[9]Good photographs are given by J. Y. Buchanan, *Proceedings* of the Royal Institution, 1909, vol. 19, p. 243; *op. cit.*, p. 233.

Chicago Women Chemists' Meeting

The women chemists of Chicago recently held an informal meeting during which the discussion was devoted to the coming meeting of the Chicago Women's Section and other pertinent topics.

The second informal dinner for women interested in chemistry is scheduled for the evening of Jan. 12 at 6:30, at the Chicago College Club, 151 N. Michigan avenue. These meetings are the result of the attendants being drawn together by common interest. Among subjects for future discussion are planned the starting of business in the tanneries, pleasing the fastidious with specially dyed costumes, and similar experiences.

The Chicago Chemist Club

The Chicago Chemist Club has elected the following officers and trustees to permanent positions during the coming year: President, William Hoskins; first vice-president, Frank M. DeBeers; second vice-president, W. Lee Lewis; treasurer, Charles E. Kawin; secretary, Paul Van Cleef; trustees: one-year term, Otto Eisenschmil; two-year term, F. W. Willard, L. V. Redman; three-year term, H. O. Baker. Final arrangements have not yet been made with respect to the future headquarters of the club. Among other proposals is the use of the City Club as headquarters for the time being.

International Research Council Monographs

Professor W. A. Noyes of the University of Illinois has been recommended by the Advisory Council of the American Chemical Society as chairman of the Board of Editors of the Scientific Series of Monographs and Dr. John Johnston has been recommended as chairman of the board of editors of the technological series of monographs which are to be prepared under the auspices of the International Research Council.

Research Organic Chemicals*

Brief Sketch of the Development of Domestic Supplies of Organic Intermediates for Laboratory Research —Illinois Vacation Quantity Synthesis Course—Department of Synthetic Chemistry, Eastman Kodak Company

By H. T. CLARKE

UNTIL 1914 the great bulk of organic chemicals employed by research workers in university and technical laboratories was obtained exclusively from Germany, the majority being supplied by the firm of C. A. F. Kahlbaum. This firm engaged in the preparation of a certain number of the products which it listed, but the majority were undoubtedly procured from outside sources. These fell into three main classes. The first class consisted of firms making a specialty of the preparation of rare chemicals, of which the most important was that of Theodor Schuchardt of Corlitz. The second class consisted of manufacturers of specialties in which there was scant room for competition and in which one firm apparently supplied the world's demand. Examples are the essential oil laboratories of Schimmel & Co., which supplied a relatively large field, and small firms such as that of Flemming, which prepared the chlorhydrins of glycerol. The third class consisted of the large chemical manufacturers, such as the important dye and pharmaceutical plants.

Owing to the wide range of products thus obtainable from the second and third classes it was possible to supply chemical research workers a large number of necessary products at relatively low cost. The special materials prepared by Schuchardt and Kahlbaum were naturally very much more expensive, since they were prepared on a laboratory scale rather than in large scale apparatus. For example, p-nitrochlorbenzene could be purchased in pure condition for 15 marks a kilo, and in technical quality for 6.50 marks a kilo, the latter material being obtained from the dye works. On the other hand the corresponding bromo compound, which is just as readily prepared in the laboratory, was priced at 0.40 mark per kilo. Again technical p-toluidine, sold at 4.40 marks a kilo, was prepared from technical p-nitrotoluene, sold at 3.50 marks a kilo, whereas p-chloraniline, obtained from technical p-nitrochlorbenzene, was sold for 10 marks per hundred grams. The procedure of preparation is identical, but in the latter case it was not carried out on a technical scale.

At the opening of hostilities in 1914 the supply of Kahlbaum research chemicals in this country was abruptly cut off. Research work continued for some time with the use of materials in the stock houses and in the store rooms of the universities, but by the middle of 1916 the position was rapidly becoming serious and it looked as if research work was coming to a halt for lack of supplies.

Research Students Prepare Large Quantities of Organic Chemicals

During this period one attempt was made by a university laboratory to meet the shortage in its stock rooms. Dr. C. G. Derick, of the University of Illinois, initiated a system of vacation laboratory work for the senior students in the organic chemical department, in which the materials most urgently required for the work of the coming semester were prepared in quantities sufficient to meet the immediate requirements. It may here be pointed out that this admirable scheme was of direct benefit not only to the chemical laboratory of the University of Illinois but to the students taking part in the manufacture, since in no other way would they be able to obtain the experience which was rendered possible by this system. On the retirement of Dr. Derick the work was continued under the direction of Dr. Roger Adams, who took it over at the time when the shortage of research organic chemicals was becoming acute. Dr. Adams therefore decided to throw open the facilities of his laboratory to chemists throughout the country, and by so doing was able to bring relief to the quarters where the distress was greatest. On the entry of the United States into the war this work at the University of Illinois was extended, and the laboratory was able to afford material assistance to the Government by synthesizing small quantities of chemicals unobtainable elsewhere.

Eastman Synthetic Organic Chemical Laboratories

In July, 1918, a letter was published in *Science* from Prof. R. A. Gertner, appealing for an endowment of a laboratory in which this work could be carried out on a more extensive scale. It appeared to the Eastman Kodak Co. that its laboratory was in a favorable position to undertake the preparation of synthetic organic chemicals; and approval of the American Chemical Society was obtained, while ample assurance of support was readily given by the large chemical manufacturing firms in the country. Owing to the scarcity of chemists at that time it was decided to staff the laboratory entirely with women, both as chemists and as assistants, and this plan has been adhered to throughout the progress of the work.

The activities of the department of synthetic chemistry, as it is called, fell into three main classes: Firstly, the synthesis of materials for which there is no other source of supply; secondly, the purification of intermediate and other chemical products which could be obtained from manufacturing firms, and thirdly, the distribution of these chemicals. It was decided not only to sell pure chemicals but also to make available to research workers the various dye intermediates and technical products which could be obtained from the manufacturers. The firms manufacturing such chemicals do not welcome orders for small amounts of their products such as would meet the requirements of laboratory workers, but have willingly supplied not only 50 to 100-lb. lots of the products which they place on the market, but also many of those which they prepared

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exclusively for their own use. The retailing of small amounts of such materials to the chemical public is thus of benefit both to the consumer and the producer.

In addition to these technical chemicals and the pure chemicals prepared from them, there are available a number of products which, while not of the highest grade, are yet sufficiently pure for general synthetic purposes. These chemicals can naturally be held at a lower price than those of the highest purity, since in many cases more than half of the cost of the pure products is represented by purification.

Synthetic organic chemicals of value in general research have been obtained from the pharmaceutical and perfume manufacturers such as Parke, Davis & Co., Frederick Stearns & Co., the Abbott Laboratories, the Florasynth Laboratories, Antoine Chiris & Co., Van Dyk & Co. Particular mention should be made of the Dow Chemical Co., which has in several instances made special runs of particular organic chemicals otherwise unobtainable in quantity.

Continued assistance comes from the University of Illinois and from certain individuals in other university laboratories. It should here be mentioned that the excellent methods published by the University of Illinois have in many cases been adopted by commercial firms.

Six Hundred Compounds Listed

At the present time, only a few months after the beginning of the undertaking, the list includes nearly 600 different compounds, the majority of which are pure. Two considerations have influenced the selection of the substances prepared: on the one hand, attempts have been made, whenever feasible, to supply compounds for which especial inquiries had been made; on the other, the choice of new preparations has been largely determined by the materials at hand. Extensive use has been made of the ready availability of certain products which were hitherto considered as little more than chemical curiosities.

Firms Producing Specialties

During the past year several concerns have started the manufacture of some of the less common organic chemicals, the demand for which is not as great as is the case with dye intermediates. Mention may be made of the Digestive Ferments Co. and the Special Chemicals Co., which are manufacturing a line of pure bacterial sugars and allied compounds. The last named firm, which was organized primarily for the purpose of assisting to make the United States independent in research chemicals, is also supplying a number of general organic reagents, as are the Eimer & Amend Co., the Cyclic Chemical Co., the Research Laboratories of Chicago, the Organic Products Co., the Saginaw Laboratories and others.

Co-operation Required

In order that production of research organic chemicals should be a success, it is essential that they have the support of the universities, especially during the first few years. It cannot be denied that with the present state of labor the cost of research chemicals will be considerably higher than the prices at which Germany was able to sell them before the war, and should Germany find a market for its products in this country during the initial period, there can be no doubt that the attempts to render the United States independent of Europe in these commodities will have to be discontinued.

Their continuance is, moreover, contingent upon the success of the American chemical industries, since it is from these industries that the basic materials for the preparation of the research products must be obtained. But the success of the chemical industries depends in the long run upon the continuation of chemical research, for the country where chemical research of a theoretical nature is most intensely pursued will be the country to lead in chemical technology. The by-products of the researches carried out by university workers have formed and will form the basis of new technical processes and products.

It is therefore necessary that the materials for the carrying out of research work be close at hand; a research worker who wishes to experiment on a new line and requires special materials for his work is apt to lose enthusiasm if forced to wait three months or more for the arrival of the necessary starting products.

To further the success of chemical research and thereby to give the country the full advantages of their work, it is most advisable that university workers should co-operate as closely as possible. In order to avoid duplication of effort it would be well to permit a free exchange of new observations and products. The former is effected through the channels of the scientific publications, but very little has been done with regard to the organization of the exchange of materials. The Eastman Kodak Co. is accordingly inviting research workers to mail to it small quantities of new and interesting chemicals which they may prepare in the course of their work. Such chemicals can then be listed and distributed for research purposes. Great assistance would be afforded by universities if they were to follow the example of the University of Illinois in the undertaking above referred to, for this work has resulted not only in the output of urgently required chemicals, but—even more important—in the production of highly equipped chemists, upon whom as a class the future success of chemistry in the United States depends.

Japanese Decision on Trade Marks

The Supreme Court of Japan, in a suit instituted by a Philadelphia company for the protection of its trade mark rights, has handed down a decision which is of great importance to international trade.

The Miller Lock Co. adopted as its trade mark a scroll containing the name "Miller." This was registered in the U. S. Patent Office, Oct. 8, 1906, and in 36 other countries, date of registration in Japan being March 26, 1907. In 1916, it was found that the Crown Lock Co. of Tokyo was manufacturing imitations of the Miller padlock and stamping them with a fac-simile scroll containing the word "Crown" or "Million." Legal proceedings were instituted claiming infringement by means of the scroll containing the word "Crown." The Japanese Patent Office sustained the American owners of the trade mark. The case was then carried to the Supreme Court of Japan, which rendered a similar decision. The Court considered the question to be whether or not the imitation mark, notwithstanding the substitution of different English letters as embodied in the word "Crown" for the English letters constituting the word "Miller," would be sufficiently close to the registered mark to cause confusion in the minds of Japanese purchasers.

A Square Deal for the Electric Furnace*

BY H. G. WEIDENTHAL

THE advantages of the electric furnace have been dwelt upon individually and as a whole by the proponents of the various types and makes of furnaces, and to some extent the shortcomings of the electric furnace have been brought out and discussed. Among the users of electric furnaces the great majority are enthusiastic boosters, but it is true that a small minority have found that they made a mistake in choosing a type of equipment not suited to their particular class of work. In some instances the furnace was not sufficiently rugged to stand the strain, so that the cost of upkeep plus the lost time of delays has discouraged the user.

Lack of practical melting and general steel plant experience has caused trouble for more than one high-class designer making his first attempt on an electric furnace. Designers of steel plant equipment have learned by experience that simplicity and extreme strength are essential, because of the temperature conditions to be met and because of the mental attitude of men working around hot metal. When working in the heat and under the potential hazard prevailing around a furnace or mill, men are naturally less considerate of the welfare of machinery than men working under cooler and less hazardous conditions. Failure to recognize this on the part of some furnace builders has given grounds for criticism by old steel plant men. This is unfair to the electric furnace, for it can be designed sufficiently simple and rugged to meet steel plant requirements.

SOURCES OF APPARENT DISSATISFACTION

Another source for apparent dissatisfaction among users of electric furnaces is directly chargeable to the users themselves. There are two classes of offenders. First, those who are familiar with the steel or casting business but do not appreciate the exclusiveness of the new equipment which they install. Instead of employing the proper men to operate the furnace intelligently, they buy it as they would a new cupola or a ladle and turn it over to some old "dyed in the wool" melter or blower to abuse as he sees fit. If this man is not exceptionally progressive, he has a fear of electricity and may even entertain hallucinations as to the effect of electric current on steel. At any rate he is seldom enthusiastic about his new care and does not give it a fair deal.

The second class of offender is the man or group of men who know little or nothing about the operating end of the steel business or casting business, whichever it may be that they embark upon. They have heard that the electric furnace runs itself and is the panacea for all the ills of the steel business. They expect by the use of this great device to sidestep the long years of apprenticeship and honest endeavor that the steel man has gone through to produce good steel. To them, pouring practice, ingot practice, cogging, forging and rolling, with their many very important details of temperatures, time of heating, etc., are merely unimportant details, for, as they think, "the electric furnace makes steel that cannot go wrong." They may even conclude that the so-called technique of steel manufacture is all unnecessary, but what happens when they try to market their product? The steel is piped, full of blow-holes, seams, slag, and they reverse their ideas and blame it all on the furnace. Is this fair to the electric furnace?

Now at last we come to the user who is getting satisfactory results and is really pleased with his electric furnace. He is a booster for the make of furnace which he has purchased and generally speaking he is well disposed toward all electric furnaces. Apparently he is doing all he can for himself and the industry, but is he really boosting the electric furnace to the unconvinced or partially convinced user of steel?

ELECTRIC VS. OPEN-HEARTH STEEL

It is a proved fact that properly made electric steel is far superior to open-hearth steel, and that the best makes equal and in certain cases excel crucible steel. Electric tool steels have made their mark and are here to stay. High-speed steels, alloy tool and plain carbon tool steels are being made which compare well with the best crucible grades. Electric alloy die blocks are giving exceptional service and promise to put the cheaper grades off the market. Some automobile manufacturers and makers of automobile parts are specifying electric steel for drive shafts, gears, and in a few cases for drop forgings. This last field is still in its infancy, but there the need for high-grade steel is very urgent. A large number of failures in drop forgings are due to dirty steel and segregations found in the open-hearth forging steels.

Forge shops making machinery forgings, shear blades, blanking dies, etc., are beginning to appreciate the merits of electric alloy steels and are using them quite extensively.

In the steel casting business only very few plants are specializing in high-grade and alloy steel castings, although a very profitable field is being developed for alloy steel castings. The majority are competing with converter and open-hearth castings, both in price and with regard to quality. It is quite true that by using the electric furnace as a melting unit and attempting little or no refining, it is possible to produce steel for castings at the same cost or in some cases even cheaper than by the converter or small open-hearth. Another reason for the use of an electric furnace for castings is the flexibility and ease of analysis control.

TRADE NAME SHOULD STAND FOR QUALITY

It is perfectly legitimate for the casting manufacturer to take advantage of economies offered by the electric furnace, but if he does not make full use of the ability of the furnace to produce high quality steel, such castings should not be advertised as electric furnace product. The desire on the part of the manufacturer for large production and low cost should not become a reflection upon the electric furnace. It may be true that the trade does not demand a high-grade steel casting, but if "Electric Steel Castings" are sold to the trade, it should be supplied with material having a quality which is implied by the trade name "Electric Steel Castings."

Are the manufacturers of electric steel ingots, billets and bars producing the very best product that the furnace is capable of? Yes, some are producing excellent material, some are producing good material in the furnace, but are not careful enough about their pouring, mold practice, cooling, reheating, forging or rolling. Others make good steel most of the time, but feel that

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they cannot afford to remelt off heats, so they try to dispose of them either as their regular product or in some cases as open-hearth steel. Some of these heats are off in analysis, as was the case with one lately brought to the writer's attention which analyzed 0.065 phosphorus, but was sold as high-carbon chrome-vanadium shear blade stock requiring tool steel quality. Of course the steel failed and went back to the producer after the purchaser had lost a great deal of time and money trying to use it. Another very recent example is of some 3.5 per cent nickel steel for Navy work. The analysis was correct, but the steel was so full of non-metallic inclusions that it fell down miserably on its physical requirements. The writer is forced to admit that this steel was as bad or worse than any open-hearth steel he ever saw. It may be possible that in both of these instances the steel was made under adverse conditions such as bad bottom, bad roof or walls, forcing the operator to hurry the heat lest a breakdown catch him with his heat unfinished. This, however, is a poor excuse, for the proper course is that adopted by at least one plant which has a strict rule that no heat shall be rushed to completion because of furnace troubles, but that in such emergency the melter shall, as soon as possible, pour the heat without alloys. This material can only be used for remelting, and there is not even a temptation to apply it on an order. At the same time the cost of alloys is saved.

Major Causes for Poor Heats

In addition to furnace breakdowns, there are two other major causes for poor heats. One is the quick heat single slag method, that is, no dephosphorizing slag is removed. The result is not only higher phosphorus content, but all foreign substances adhering to the scrap remain in the furnace to contaminate the finishing slag. At times this practice makes it impossible to obtain the proper conditions for finishing the heat, so that the steel is no better and may be worse than the better makes of open-hearth steels.

The second cause has several angles and is not so very easily controlled. It is ignorance of proper temperatures, not only for pouring but for certain reactions which, as is not generally recognized, cannot occur except within certain temperature ranges. The common failing of pouring at too high a temperature is little worse than working a heat at too low a temperature. This temperature phase is too large a one to be included here, but would be an excellent topic for a symposium.

An investigation of the two cases above and a number of other cases where electric steels have not lived up to their reputation reveals that the makers of these steels are low bidders in each case, and the price was about that of open-hearth alloy steel. What does this indicate? It looks as if electric steel manufacturers were willing to sacrifice quality to compete in price with open-hearth steel. This is not all; some companies have gone still further; they offer "electric steel made to open-hearth specifications" at the price of open-hearth steel and another grade known as electric steel made to electric specifications at an advance of 2c. per pound over the other price. Why should there be any call for such a policy?

Public Educated to Need for Higher Grade Steels

The steel-consuming public has been educated to the need of higher grade steels during the war. The electric steel maker should continue to cultivate this good seed, instead of choking it off by prejudices born of this price-cutting policy. He should remember that when the price of open-hearth steel advanced from 250 per cent to 400 per cent, the price of his own product in a very few cases advanced as much as 100 per cent in spite of the higher cost of power, labor and raw materials. Only a part of his raw materials have dropped in price, while labor and power are still advancing. Even during the artificial process of price-setting lately foisted upon the steel industry, no definite price has been set on electric quality steel, and why should the manufacturers themselves start a campaign of cutting prices, and worst of all, cutting quality?

If the electric steel producer is an intelligent business man, he must realize that one ton of carelessly made steel may curtail more sales of electric steel than he could obtain by cutting his price to below his cost. The public soon forgets the many good shipments he has made, but one bad lot of steel leaves a bad taste, which salesmanship of the higher caliber may slightly sweeten but can never completely eradicate.

An awful epidemic of poor steel has existed since the signing of the armistice, probably due to a letting down after-war tension. This applies to all grades and makes of steel, but, as before mentioned, electric steel of late has not been all that it might be. Unfortunately, a large number of steel users are not equipped to thoroughly investigate a shipment of steel before putting it into work. They often spend more than the cost of the steel in forging, treating or machining before the fact is discovered that the material is defective. Of course the maker replaces the steel, but he does not repay the user for the work he has done upon it nor for the delays due to replacement. A discriminating buyer could well afford to pay more for his steel if the maker was so sure of his product that he could guarantee not only replacement but guarantee the purchaser against any loss due to defective steel. Why not get the proper price and in turn give only the best that can be produced by the electric furnace?

Every man making electric steel, if he is a normal man, cannot help but develop a feeling of attachment for his furnace and for the industry. Let him do justice to himself and his business and at the same time give the electric furnace a square deal.

The James H. Herron Co.,
Cleveland, Ohio.

Swansea Iron Works to Adopt American Process

An American process for the sintering of fine ores and sulphide ores is about to be adopted by six iron and steel and zinc manufacturers in Swansea, Wales. A representative of a well-known American metallurgical company was recently in this district at the invitation of leading manufacturers, and placed orders with six concerns for his firm's patent machine for sintering ores. All metallurgical works using fine ores, such as iron, lead, zinc, and sulphide ores, can use this system of sintering, and it is to be expected that the future will find other local works introducing the same process. As Swansea is known as the metallurgical center of the United Kingdom and has sometimes even been called the world's center of metallurgy, great importance may be attached to this introduction of an American process for sintering. A German sintering apparatus recently adopted by a large iron and steel plant in Swansea has not been wholly satisfactory.

Tentative Regulations for the Storage and Use of Fuel Oil

Specifications of Equipment Construction: Underground, Exterior and Interior Tanks, Piping, Heating, Combustion and Feeding—150-Deg. Flash Point Regulation—Limit of Heating 40 Deg. Below Flash—Embankment Dikes—Objections and Discussion

THE Committee on Inflammable Liquids of the National Fire Protection Association at a meeting in New York, Oct. 30-31, drew up the following regulations:

Oil-burning equipments are those using only liquids having a flash point above 150 deg. F., closed cup tester. Oil-burning equipments shall be operated only when a competent attendant is constantly on the premises.

In determining the flash point, either the Elliott, Abel, Abel-Pensky or Tag Closed testers shall be used, but the Tag Closed tester (standardized by the United States Bureau of Standards) shall be authoritative in case of dispute. All tests shall be made in accordance with the methods of tests as adopted by the American Society for Testing Materials.

Storage tanks should be placed underground to obtain the greatest measure of safety. Where this cannot be done and tanks are necessarily located within the building, or above ground, such an arrangement is considered more hazardous.

Above-ground storage or supply tanks may be permitted only outside of closely built districts, or outside of fire limits.

Construction of Underground Tanks

1. *Materials of Construction.*—(*a*) Tanks shall be constructed of galvanized steel, basic open-hearth steel or wrought iron of a minimum gage (U. S. Standard) depending upon the capacity, as given in Tables I and II.

For liquids of 20 deg. Baumé and below, tanks may be of concrete.[1]

TABLE I.

Capacity (Gallons)	Minimum Thickness of Material
1 to 560	14 gage
561 to 1,100	12 gage
1,101 to 4,000	7 gage
4,001 to 10,500	¼ inch
10,501 to 20,000	⅜ inch
20,001 to 30,000	½ inch

(*b*) In outlying districts to be prescribed by inspection departments having jurisdiction, tanks not exceeding 1100 gal. in capacity, if located 10 ft. or more from any building, may be constructed in accordance with Table II.

TABLE II.

Capacity (Gallons)	Minimum Thickness of Material
1 to 30	18 gage
31 to 350	16 gage
351 to 1,100	14 gage

2. *Joints and Connections.*—All joints shall be riveted and soldered, riveted and calked, brazed, welded or made by some equally satisfactory process. Tanks shall be tight and sufficiently strong to bear without injury the most severe strains to which they may be subjected in practice. Shells of tanks shall be properly reinforced where connections are made and all connections made through the top of tank above the liquid level.

3. *Rust Proofing.*—All tanks shall be thoroughly coated on the outside with tar, asphaltum or other suitable rust-resisting material, dependent upon the condition of soil in which they are placed. Where soil is impregnated with materials, tanks shall also be made of heavier metal.

4. *Venting of Tanks.*—(*a*) An independent, permanently open galvanized iron vent terminating outside of building shall be provided for every tank.

(*b*) Vent openings shall be screened (30 x 30 nickel mesh or its equivalent) and shall be of sufficient area to permit proper inflow of liquid during the filling operation and in no case less than 2 in. in diameter and accessible for examination and removal; shall be provided with weatherproof hoods and terminate 12 ft. above top of fill pipe, or if tight connection is made in filling line, to a point 1 ft. above the level of the top of the highest reservoir from which the tanks may be filled and never within less than 3 ft. measured horizontally and vertically, from any window or other building opening.

Tanks of 500 gal. capacity or less may be provided with a combination fill and vent fitting so arranged that fill pipe cannot be opened without opening the vent pipe.

(*c*) Where a battery of tanks is installed, vent pipes may connect to a main header, but individual vent pipes shall be screened between tank and header. The header outlet shall conform to the foregoing requirements.

5. *Filling Pipe.*—Filling pipe shall be turned up so as to form a trap or seal and when installed in the vicinity of any door or other building opening, shall be as remote therefrom as possible, so as to prevent liability of flow of oil through building openings; terminal shall be outside of building in a tight, incombustible box or casting, so designed as to make access difficult by unauthorized persons.

6. *Manhole.*—Manhole covers shall be securely fastened in order to make access difficult by unauthorized persons. No manhole shall be used for filling purposes.

7. *Test Well of Gaging Device.*—See Par. 32.

8. *Setting of Tanks.*—(*a*) Tanks to be buried underground with top of the tanks not less than 3 ft. below the surface of the ground, and below the level of any piping to which the tanks may be connected, except that in lieu of the 3-ft. cover, tank may be buried 18 in. below the ground level and a cover of reinforced concrete at least 6 in. in thickness provided, which shall extend at least 1 ft. beyond the outline of tank in all directions; concrete slab to be set on a firm, well-tamped earth foundation. Tanks shall be securely anchored or weighted in place to prevent floating.

Where a tank cannot be entirely buried, it shall be covered over with earth to a depth of at least 3 ft.

[1] Investigations are under way to determine the advisability of permitting the use of concrete tanks for oils above 20 deg. Baumé.

and sloped on all sides, slopes not to be less than 3 to 1. Such cases shall also be subject to such other requirements as may be deemed necessary by the inspection department having jurisdiction. If tank cannot be set below the level of all piping to which it is connected, satisfactory arrangements shall be provided to prevent siphoning or gravity flow in case of accident to the piping.

(*b*) Tanks shall be set on a firm foundation and surrounded with soft earth or sand well tamped in place, or incased in concrete as outlined in Section 14 (*b*).

(*c*) When located underneath a building the tanks shall be buried with top of tanks not less than 2 ft. below the level of the floor. The floor immediately above the tanks shall be of reinforced concrete at least 9 in. in thickness, extending at least 1 ft. beyond the outline of tanks in all directions, and provided with ample means of support independent of any tank.

Above-Ground Tanks

9. *Materials of Construction.*—(*a*) Tanks, including top, shall be constructed of galvanized steel, basic open-hearth steel or wrought iron of a minimum gage (U. S. Standard) as specified in Tables III to VII, inclusive. No open tanks shall be used. (*b*) For liquids under 20 deg. Baumé, tanks may be of concrete.

TABLE III.

Horizontal or vertical tanks not over 1100-gal. capacity:

Capacity (Gallons)	Minimum Thickness of Material
1 to 30	18 gage
31 to 350	16 gage
351 to 1,100	14 gage

TABLE IV.

Horizontal tanks over 1100-gal. capacity:

Maximum Diameter	Minimum Thickness of Material	
	Shell	Heads
Not over 5 feet	10 gage	7 gage
5 feet to 8 feet	7 gage	¼ inch
8 feet to 11 feet	¼ inch	⅜ inch

TABLE V.

Vertical tanks over 1100-gal. capacity. Under 40-ft. in diameter and containing not more than 5000 gal.:

Bottom No. 8 gage
Bottom Ring No. 8 gage
Other Rings No. 10 gage
Top No. 12 gage

TABLE VI.

Under 40 ft. in diameter and containing more than 5000 gal., but not more than 10,000 gal.:

Bottom No. 8 gage
Bottom Ring No. 7 gage
Other Rings No. 8 gage
Top No. 12 gage

TABLE VII.

Other vertical tanks to be of thickness not less than indicated in the following table, the figures referring to U. S. Standard gage:

Diameter, Ft.	Top	Top Ring	2nd Ring from Top	3rd Ring from Top	4th Ring from Top	5th Ring from Top	6th Ring from Top	Bottom
80	10	7	7	3	0	3–0	5–0	10
75	10	7	7	4	1	2–0	4–0	10
70	10	7	7	4	1	2–0	4–0	10
65	10	7	7	5	1	0	3–0	10
60	10	7	7	5	2	0	2–0	10
55	10	7	7	6	3	1	2–0	10
50	10	7	7	7	4	1	0	10
45	10	7	7	7	5	3	1	10
40 and less	10	7	7	7	5	3	2	10

(*c*) Tanks of capacity greater than given in Table VII shall be of material sufficient in thickness to hold the contents, with a proper factor of safety. (*d*) No vertical tanks shall exceed 35 ft. in height. (*e*) Riveted joints shall have an efficiency of at least 60 per cent. (*f*) The specifications for joints, connections and rust proofing shall be the same as those for underground tanks.

10. *Roofs or Tops.*—No wooden or loosely fitting metal roofs or tops shall be permitted. Roof or top shall be without unprotected openings; shall be firmly and permanently joined to the tank, and all joints made as noted previously for underground tanks.

11. *Venting of Tank.*—(*a*) A permanently open vent conforming to that described for underground tanks shall be provided. (*b*) Each above-ground tank, over 1000 gal. in capacity, shall have all manholes, vent openings, and other openings which may emit inflammable vapor provided with 30 x 30-mesh, non-corrodable wire screen, or its equivalent, so attached as to completely cover the opening and be protected against clogging. A safety relief of 1½ per cent of roof area shall be provided, or manhole covers of equal area must be kept closed by weight only, and not firmly attached. The screen on such opening may be made removable, but shall be kept normally firmly attached and shall be accessible for inspection.

12. *Setting of Tanks.*—Tanks with bottom more than 1 ft. above the ground shall have firm foundation and supports of incombustible materials, except wooden cushions. The storage of combustible material within 10 ft. of any tank is prohibited.

13. *Protection Against Lightning.*—Metal tanks shall be constructed entirely of metal including top, side and bottom; all openings shall be hermetically sealed (See Caulking of Joints), except breather vent, which shall be screened. All tanks shall be electrically grounded, by resting directly on moist earth or grounded in accordance with the requirements for lightning protection of the National Fire Protection Association. All steel work of reinforced concrete tanks shall be interconnected and grounded by an approved method.

14. *Embankments and Dikes.*—(*a*) In locations where above-ground tanks are liable, in case of breakage or overflow, to endanger surrounding property, each tank shall be protected by an embankment or dike. Such protection shall have a capacity of not less than one and one-half times the capacity of the tank surrounded, and to be at least 4 ft. high, but in no case higher than one-fourth the height of tank when height of tank exceeds 16 feet.

(*b*) Embankments or dikes to be made of earthwork or reinforced concrete. Earthwork embankments to be firmly and compactly built of good earth from which stones, vegetable matter, etc., have been removed, and to have a flat section at top of not less than 3 ft. and a slope of at least 2 to 1 on both sides.

(*c*) Embankments or dikes shall be continuous, with no openings for piping or roadways. Piping shall preferably be laid over or under embankments; if it is necessary to install pipes through embankments concrete wing walls shall be provided. Brick or concrete steps shall be used where it is necessary to pass over.

Tanks Inside Buildings

Inside storage is regarded as much more hazardous than outside storage. Where used the following requirements shall be rigidly applied:

15. *Setting and Heat Insulation of Tanks.*—(*a*) Tanks shall not be located above the lowest story, cellar or basement of building.

(*b*) Tanks shall be located below the level of any piping to which they may be connected, or if this is im-

practicable, satisfactory arrangements shall be made to prevent siphoning or gravity flow in case of accident to the equipment or piping.

(*c*) Tanks shall be set on a firm foundation and those exceeding 2500-gal. capacity shall be supported independently of the floor construction.

(*d*) Steel tanks shall be completely enclosed with a heat insulation of reinforced concrete not less than 12 in. in thickness, with at least a 6-in. space on sides between tank and concrete insulation filled with sand or well tamped earth, and with 12 in. of sand on top of tank, either between tank and concrete slab or above concrete slab.

(*e*) Concrete tanks shall be completely enclosed with a heat insulation of reinforced concrete not less than 8 in. in thickness, with at least a 6-in. space on sides between tank and concrete insulation filled with sand, or well tamped earth, except that for top of tank an insulation of 12 in. of sand without concrete covering shall be deemed sufficient.

(*f*) Walls of concrete tanks shall be constructed independently of and not in contact with the building walls.

16. Vents shall be installed as previously described.

Location and Capacity of Tanks for Underground Storage

17. Tanks shall preferably be located at least 50 ft. from important buildings. When this cannot be done, the limit of individual tank capacity permitted shall be dependent on the location of tanks with respect to adjacent buildings, as follows:

(*a*) Tanks may be of unlimited capacity if buried underneath or lower than any floor or pit of any building within 50 ft. radius of the tank. (*b*) Where a building having a floor or pit lower than the tank is within 40 ft. radius, the capacity of the tank must not exceed 500,000 gal. (*c*) Where a building having a floor or pit lower than the tank is within 30 ft. radius, the capacity of the tank must not exceed 200,000 gal. (*d*) Where a building having a floor or pit lower than the tank is within 25 ft. radius, the capacity of the tank must not exceed 150,000 gal. (*e*) Where a building having a floor or pit lower than the tank is within 20 ft. radius, the capacity of the tank must not exceed 100,000 gal. (*f*) Where a building having a floor or pit lower than the tank is within 10 ft. radius, the capacity of the tank must not exceed 75,000 gal. (*g*) If tank is within 10 ft. of any building, and the top of the tank is above the lowest floor or pit of the building, the tank shall not exceed a capacity of 50,000 gal., and must be of metal entirely enclosed in concrete.

Above-Ground Storage

18. (*a*) The relation between capacity of individual tanks and the permissible distance from other property is shown in Table VIII.

(*b*) For tanks ot 400,000-gal. capacity or greater, a minimum distance of 175 ft. to adjoining property or nearest building may be permitted, provided that an approved type of extinguishing system is installed for the tank and covering other parts of the yard or system.

(*c*) For tanks permitted from 50 ft. and up to 175 ft. of building or property line, the capacity may be increased 33 per cent if the tank is provided with an approved extinguishing system.

19. *High Water.*—Tanks shall be so located as to avoid possible danger from high water.

20. *Streams Without Tide.*—When tanks are located on a stream without tide, they shall, where possible, be down stream from burnable property.

21. *Tide Water.*—On tide water, tanks shall be located, if practicable, well away from shipping districts.

Storage Inside of Buildings

22. *Permanently Set Storage Tanks Inside Buildings.*—(*a*) In ordinary buildings the gross capacity of tanks shall not exceed 5000 gal. (*b*) In fire-resistive buildings the gross capacity of tanks shall not exceed 10,000 gal. (*c*) In any building, if in a fire-resistive or detached room cut off vertically and horizontally in an approved manner from other floors of the main building, the gross capacity of tanks shall not exceed 50,000 gal., with an individual tank capacity not exceeding 25,000 gal., provided the insulating sand specified under setting and heat insulation of tanks shall be increased to 12 in. on sides and 18 in. on top.

TABLE VIII.

Capacity of Tanks, Gallons	Minimum Distance to Line of Adjoining Property or Nearest Building (Feet)
750	5
1,500	10
3,000 or less	20
21,000 or less	25
31,000 or less	30
45,000 or less	40
64,000 or less	50
80,000 or less	60
128,000 or less	75
200,000 or less	85
266,000 or less	100
400,000 or less	150
666,000 or less	250
1,333,000 or less	300
2,666,000 or less	350

Piping—General Requirements

23. *Cross-Connections.*—Cross-connections permitting gravity flow from one tank to another except through open connections shall be prohibited. This shall not be construed as prohibiting properly gated connections through subdivisions in any individual tank.

24. *Workmanship.*—All pipe connections to tanks and other oil containing or using devices, shall be made in a substantial, workmanlike manner.

25. *Type of Material.*—All piping shall be of the standard full weight wrought iron or steel type for working pressures less than 100 lb.; for working pressures in excess of 100 lb., extra heavy pipe and fittings shall be used. No pipe less than ⅛ in. internal diameter will be permitted.

26. *Installation.*—Piping shall be run as directly without sags, and so laid that where possible pipes pitch toward the supply tank without traps; provision shall be made for expansion, contraction, jarring and vibration.

27. *Tests.*—Piping for systems with working pressures under 100 lb. after installation shall be tested and proved tight at a pressure of not less than 150 lb.; where working pressures exceed 100 lb., piping shall be tested and proved tight at a prsssure 50 per cent in excess of the working pressure.

28. *Unions.*—Union, if used in place of right and left couplings, shall be of an approved type.

29. *Protection to Piping.*—(*a*) Piping between any separated oil containing or using parts of the equipment shall be as far as practicable laid outside of the building underground, and properly protected against corrosive action; if necessarily inside it shall preferably be laid in a trench with proper metal cover; if on floor or subject to mechanical injury it shall be protected.

(*b*) Pipes leading to the surface of the ground or above the floor, particularly risers to furnaces, shall be cased or jacketed when necessary to prevent loosening or breakage.

(*c*) Fill and vent pipes shall be protected in a substantial manner against mechanical injury.

30. *Outside Piping.*—(*a*) All outside piping shall be laid in solid earth, or in a trench. Oil pipes shall not be located near, nor in the same trench with other piping, excepting steam lines for heating. Propping the pipes on wooden blocks shall be avoided. (*b*) Openings for pipe through outside walls below the ground level shall be made oil-tight and securely packed with flexible material.

31. *Valves.*—(*a*) All valves shall be of an approved type. (*b*) Shut-off valves shall be provided on both sides of any strainer which may be installed in pipe lines; in discharge and suction lines to pumps; in discharge and return lines to any tank, as near as practicable, and in branch lines near burners. (*c*) A check valve of an approved type shall be installed in each air line near the burner. (*d*) A pressure relief valve shall be installed in supply lines to burners and so arranged as to return surplus oil to supply tank. (*e*) The use of automatic shut-off valves for the oil supply is recommended.

32. *Oil Level Indicating Device.*—A test well or gaging device shall be installed, and so designed as to prevent the escape of oil or vapor within the building at any time. Top of well shall be sealed and, where located outside of building, kept locked when not in use.

33. *Strainers.*—Suitable strainers shall be installed in the suction line. Large basket strainers are recommended in the receiving or filling line of storage tank to remove dirt and foreign matter.

Heating

34. *Heating of Tanks.*—(*a*) Where it is necessary to heat oil in storage tanks in order to handle it, the oil shall not be heated to a temperature higher than 40 deg. F. below the flash point, closed cup. (*b*) Heating shall be done by means of properly installed coils within the tank, using only steam or water. Thermostatic control and thermometer shall be provided for all heating devices.

35. *Heaters, Other Than Those for Tanks.*—(*a*) Heaters shall be of substantial construction; all joints shall be made oil-tight. (*b*) Only steam or water shall be used for heating. (*c*) Heater shall be by-passed so that in warm weather it will not be under constant pressure while not in use.

Fuel Oil Burners

36. (*a*) The burner mechanism shall be so designed as to not enlarge the orifice, and so that the needle valve cannot be unscrewed and removed in operating.

Pumping Systems

37. Oil shall be pumped from tank to burners. Systems where burners are supplied by gravity, or pressure on tanks are prohibited.

38. *Pumps.*—(*a*) Pumps shall be in duplicate, of an approved design, and secure against leaks. (*b*) They shall be located in a room cut off from oil-burning devices and provided with entrance which can be reached without passing through room where burners are located; if this is not practicable, provision shall be made for remote control. (*c*) Pumps used in connection with the supply and discharge of storage tanks shall be located outside the tank or embankment walls, and at such a point that they will be accessible at all times, even if the oil in the tank or reservoir should be on fire.

Objections to the Regulations

The following are the objections that have so far come to the attention of the American Petroleum Institute.

In commenting on these criticisms, the Institute desires that the reasons for asking for any changes should be clearly stated, as it is concerned with both the practical side of the question and the economic effect these regulations are likely to have.

Flash Point 150 Deg. F.—This is too high, and while not necessarily arrived at in consideration of the U. S. Navy fuel oil specifications, where altogether different conditions are met with, the effect is the same. In oil fields and in many industrial establishments where fuel oil has been in constant use for a great many years oils of a much lower flash point have been used without accident and fire arising from the point of flash. It is clear that oil having a flash point of 100 deg. F. is safer than an oil that flashes at 30 deg. F.; but above atmospheric temperature, for storage purposes an oil that flashes at 200 deg. F. is no more dangerous than that which flashes at 600 deg. F. In the same sense, if an oil is well above atmospheric temperature, it is just as safe with its flash point at say 135 deg. F. as it would be at 150 deg. F. The flash point of oils is most generally accepted as the index of the fire hazard because it is not until the oil has been heated to its ignition temperature (i.e., fire point) that explosion takes place in the body of the oil. Oil cannot ignite at the temperature of its flash point, and therefore, if suitable provision for venting is made, such small volumes of gases as may be given off before the oil reaches the temperature of its fire point should vent themselves, and cannot cause a conflagration of the oil in the tank. A tank that is not a still and from which combustible material is kept is perfectly safe. A flash point of 135 deg. F. has been suggested, which for all practical purposes is contended to be as safe as 150 deg. F., and is a great deal easier to be met with by fuel oil producers all over the country. To set 150 deg. F. as the minimum flash point is to exclude oils of lower flash, and we are desirous of knowing just what effect this would have upon the industry.

Par. 1 (*a*).—Question has arisen as to whether there is preference for the use of the Birmingham gage over that of the U. S. Standard. Galvanized steel would be unnecessarily expensive, since fuel oil would not have a corrosive action upon ungalvanized steel, and painting of tanks should afford every protection for exterior.

Par. 2. "All connections made through top of tank above liquid level."—Bottom connections from storage tanks should be permitted. The statement of the chairman of the Committee on Inflammable Liquids that permission may be secured for such bottom connections is not in itself sufficient and the regulations should properly provide for this. It is argued that it is impossible to empty tanks over 12 to 15 ft. in height from connections made from top above the liquid level.

Par. 9.—Provision should be made that rectangular be rewritten and the burying of tanks be reduced to less than 3 ft. where there is no live load. It is also suggested that a tank may be buried 12 in. below the ground level instead of 18 inches.

Par. 9.—Provision should be made that rectangular tanks of suitable strength shall be permitted.

Par. 9 (*a*).—Change U. S. Standard to Birmingham. See also Par. 1 (*a*).

Tables III to VII.—A large refiner states that "regulations should permit the use of metal tanks without limits to dimensions so long as an established factor of safety is observed. Therefore we recommend that all dimensions of tanks be eliminated."

Par. 9 (*d*).—Some vertical tanks are 48 ft. high. If you have any objection to 35 ft. we would like to know what has been your experience in this respect and what you would suggest as practicable.

Par. 9 (*e*).—It has been suggested that 60 per cent be changed to 50 per cent and that the following be added: "but a less efficiency will be allowed if the factor of safety of the tank is 3 to 6."

Par. 10. "Roof of top. . . . . shall be firmly and permanently joined to the tank."—If anything goes wrong the roofs cannot be lifted. It should be noted in this paragraph in connection with paragraph 2 that bottom connections including bleeders are not permitted.

Par. 14.—Embankments or dikes are without doubt advisable where crude oil is stored, but it has not been the practice in many quarters to provide them for tanks holding fuel oil distillates. This provision would not necessarily insure protection, since they would become filled with rain and the water become stagnant, polluted, prejudical to health, and a breeding place of mosquitoes, while if free of water in time of fire they would soon become filled with water that may be used in extinguishing fire. Moreover, these dikes, if not filled with water, would be in the nature of "catch-alls" for waste paper, etc. If you think this provision will prove an unnecessary burden it would be advisable to state what has been the general practice in this respect.

Specifications for Concrete Tanks.—This section has been set aside pending the outcome of the test to be conducted by the Committee on Concrete Tanks of the American Concrete Institute, which will probably cover a period of two months. The results of these tests are to be submitted before the convention of the American Concrete Institute to be held in Chicago next February, but without doubt the National Fire Protection Association will be guided by these tests in fixing specifications upon concrete tanks before that time.

Moreover, the provision that "for liquids of 20 deg. Baumé and below tanks may be of concrete"—Par. 1 (*a*) and 9 (*b*)—should also be set aside until the tests have been completed. It is well known that oils of lighter gravity than 20 deg. Baumé have been stored successfully in concrete tanks.

Pars. 17 and 18.—It is contended that distance of tanks from buildings cannot be economically determined by a set rule, as hazards and practicability of each location must have special consideration.

Par. 22.—It is the practice to maintain on hand 14 days' supply of coal. Office buildings are now using as much as 4000 to 5000 gal. of fuel oil daily, and it is necessary that as much as from 40,000 to 50,000 gal. be kept in storage during cold weather. If tanks are properly designed and built, is there any particular reason why special provisions should be made for special fire-resistive rooms when as much as 50,000 gal. are to be kept in storage? What has been the general practice?

Par. 34 (*a*).—This provision has the effect of stating that the flash point is not a measure of the hazard, and seems unduly severe, for in practice fuel oil in storage is frequently heated to a temperature higher than 40 deg. below its flash point.

Par. 38 (*a*).—This has been much disputed. It does not give consideration to those smaller installations where the duplicate pump is not only economically a burden but is unnecessary because cessation in operation permits time for cleaning and repairing.

Par. 38 (*b*).—This paragraph requiring pumps to be located in a room cut off from oil-burning devices has been strongly objected to. What is your attitude toward this provision?

Great Future Predicted for the Anhinga Fiber Industry

The plant known as anhinga is a native of the State of Para, Brazil, and it is declared that this State alone is capable of producing 100,000 tons annually for export.

The anhinga constitutes the raw material from which cellulose for the manufacture of linen paper is obtained. The fibers may also be transformed by a chemical process into an artificial cotton fiber. The fact that this fiber does not decay gives it an advantage over that obtained from analagous plants. The anhinga grows along the banks of all the rivers of Para, which have a slow current, permitting a soft bed of mud for their roots. In 1908 the Commercial Association of Para received a letter from a paper factory as to the possibilities of obtaining this fiber in large quantities, but at the time the association was unable to find anyone to exploit the industry, because of the large and easily acquired profits afforded by the rubber industry. However, experiments were made last year with excellent results, and those interested in the new industry have recommended that abandoned sugar mills be fitted up for the treatment of the fiber. A mill already in operation is producing 600 kilos daily. The price of the fiber at Para is 300 to 350 reis per kilo. It is stated that the head of the Para State Chemical Laboratory has discovered a new process for dissolving the fibers, transforming them into very fine, white fibers, like cotton fiber of prime quality. Moreover their structure is superior to that of the cotton fiber, since the lines are straight and parallel.

The Chemical Industry in China

Ho Hsin Smelting Works, capitalized at approximately $550,000, has commenced operations at Pootung and aims to become one of the leading steel works in China. Its daily output at the time of the latest available report was 10 tons of pig iron. When the plant is completed the output will be 40 tons daily.

Under the direction of Japanese chemists certain chemical products such as caustic soda, creosin, stearin and soaps have been manufactured in Kwantung during the war. The raw materials were brought from Manchuria.

A committee of chemical investigation reports that there is in Manchuria a great abundance of raw materials suitable for use in the chemical industry, awaiting only active participation of capital to yield large returns.

More than 20 cotton spinning and weaving mills are now being operated at Shanghai. British, Japanese and Chinese interests are predominant. Large tracts of land at Yangtzepoo and Pootung have been purchased by Japanese interests and extensive mills are being erected. It is reported also that a number of modern office buildings requiring building materials of many types are about to be erected in Shanghai.

Patent Rights and Remedies

By Chesla C. Sherlock

BEFORE a patentee can seek damages for an infringement of his patent or invention, he must know just what his rights are under the law and what constitutes an infringement.

It is not necessary, for a patent right to be violated, for the infringing device to be identical with the patented article in form and appearance. A long line of cases holds to the view that proof of adoption of the substance of the patent is sufficient to show infringement.

"In one sense," said Mr. Justice Brown, "it may be said that no device can be adjudged an infringement that does not substantially correspond with the patent. But another construction, which would limit these words to the exact mechanism described in the patent, would be so obviously unjust that no court could be expected to adopt it."

However, there are upwards of fifty cases decided by the United States courts in which it is held that the patentee is to be protected only in respect to the precise device which he has claimed and described in his patent. And another long line of cases is authority for the statement that a machine or process which is substantially different is no infringement.

What Is an Infringement?

In Winana v. Denmead, 14 U. S. (L. ed.), 717, and Werner v. King, 96 U. S., 218, it was held that "when form and substance are inseparable, it is enough to look at the form only. When they are separable, where the whole substance of the invention may be copied in a different form, it is said to be the duty of the courts to look through the form for the substance of the invention—for that which entitled the inventor to his patent, and which the patent was designed to secure; where that is found it is an infringement; and it is not a defense that it is embodied in a form not described and in terms claimed by the patentee."

Nor will the law permit the infringer to escape punishment where he has adopted a substantial equivalent of the patented article, for the substantial equivalent of a thing, in the sense of the patent law, is the same as the thing itself; so that if two devices do the same work, in substantially the same way, and accomplish substantially the same result, they are the same even though they differ in name, form and shape.

How Patentee May Assert Rights

Having this brief statement of what will ordinarily amount to infringement, we are now able to pass on to a consideration of the more important phase of the subject, namely, the manner in which the patentee or those holding under him may assert their rights under the patent.

In the first place, it must be kept in mind that the inventor has no exclusive right to his invention until he has acquired a patent. It is the patent that conveys these rights and not the invention, and no suit can be maintained without such patent.

The very first obligation on the part of one bringing a suit for infringement of a patent is that he must allege that he is the original inventor and patentee, or that he holds under a patent so taken out. This does not mean that in the absence of a patent an inventor has no rights in his invention, but it simply means that the rights hereinafter mentioned do not belong to any but those who may show that they hold under a patent. The inventor certainly has a property right in his invention, and this property right will be enforced by a court of equity.

The suit must be brought in the name of all parties interested in the patent at the time it was infringed, whether the patentee, assignee, grantee, or all of them jointly.

It is essential, in order to assert the rights under a patent, to mark the patented article with the date thereof, and where this is impracticable to note it on the wrapper or carton. It is also necessary to give notice to the infringer that he has infringed the patented device, and it has been held that neglect to place the date of the patent on the article will not defeat the rights of the patentee provided he has given notice of infringement to the infringer, as it accomplishes the same result.

As to how the infringement is determined by the courts and juries, there are many rules and practices. In the case of machinery, for instance, the two machines are set up side by side and the question is determined by comparison. The burden of proof is upon the plaintiff or patentee, unless the defendant specifically admits that he has infringed the patented article.

Rule on Recovery of Damages

As a rule, the patentee is entitled to recover such damages as he may show that he is entitled to. There has been a great deal of discussion as to whether royalties on the infringing article made and sold were not the proper basis of damage for the patentee.

Mr. Justice Field has said: "In order that a royalty may be accepted as a measure for damages against an infringer who is a stranger to the license establishing it, it must be paid or secured before the infringement complained of; it must be paid by such a number of persons as to indicate a general acquiescence in its reasonableness by those who have occasion to use the invention; and it must be uniform at all places where the licenses are issued."

Where the patent has been infringed before a royalty has been established, the patentee may show what a reasonable royalty would have been and, upon such showing, use it for a measure of damages against the infringer.

It is also a right of the patentee, upon a showing of infringement, to have an accounting of the business done by the infringer, especially an accounting of the profits of the infringing device, and, upon a showing of them, recover all of the profit made by the infringing device.

However, he cannot hold the infringer for profits which were not made, and in this case his remedy is for damages in such amount as he is able to set up and recover.

We have found, then, that a substantial infringement of the patented device is sufficient to constitute infringement in the sense of the patent law, and that the patentee may recover profits, if there have been any; or damages, or a royalty on the articles manufactured, and where no royalty was established, a reasonable royalty on the device.

Phosphatic Coatings for Rust Proofing Iron and Steel

By L. E. Eckelmann

Among the most successful and comparatively recent developments in the non-electrolytic rust proofing of iron and steel is that employing phosphatic iron as a protective coating. All of the older processes of rust prevention, such as the Browning, Bower-Barff and others similar in principle, though giving moderately good coatings and, in the case of the Browning method, beautifully colored and lasting finishes, were uneconomical of time, expenditure of heat, and in some cases required a multiplicity of operations. The personal skill and experience of the operator were also most important factors in many of these processes where high temperatures, muffles and combinations of fused salts were used.

Recent phosphatic rust proofing differs from other methods in that the dimensions or sharpness of finely machined edges and surfaces of the articles are not appreciably altered. Due to the low temperatures used, the physical properties of tempered steel are in no way affected, and magnets so treated retain their magnetic force. Even very fine springs do not have their elasticity impaired. Fig. 1 is an illustration showing the remarkable adhesion or molecular bonding of the phosphatic coatings. On the other hand, dental needles having points so fine (0.003 in.) that a slight corrosion ruins them completely are successfully protected by phosphatic coatings without injuring the elasticity of the needles or affecting the delicate barbs covering their surfaces.

Coslett's Process

Rust proofing is effected simply by immersion of the clean objects in a hot solution for periods of one to three hours. The deposition of the coating depends upon the action of a solution of iron phosphates in weak H_3PO_4 on a metallic base, such as iron. Phosphoric acid solutions will dissolve ferrous phosphate within certain

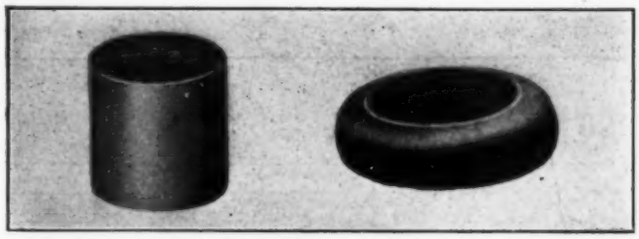


FIG. 1. PHOSPHORIC COATING IS NOT SPLIT OFF BY LARGE DEFORMATION

(On left—Before compression. On right—After compression. Both actual size)

limits in direct proportion to the concentration of the acid present. If any base or metal be added—for example, iron—capable of entering into combination with the free acid present in such a solution, the formation of ferrous phosphate on the metallic surfaces will precipitate this salt back on the iron at the point of solution. The already saturated condition of the iron phosphate solution will naturally aid the precipitation when more of this compound is formed. The action proceeds with the evolution of hydrogen until no more elemental iron is exposed, the article being then completely coated with a basic iron phosphate.

This reaction was the basis of the process developed by Coslett in 1907, its later commercial adaptation operating as follows: Ferrous phosphate made by mixing iron filings with concentrated H_3PO_4 sufficient to form a semi-fluid paste was added to weak boiling phosphoric acid. Iron or steel articles were immersed in this boiling solution for three or four hours, and when removed were covered with a rust-resisting light gray deposit of basic ferrous phosphate. The difficulty of obtaining uniform coatings, the great amount of suspended salt adhering to the work—in some cases incorporating itself with the actual coating and increasing the dimensions of the articles—the consequent necessity of rinsing the work after treatment, and the non-uniformity of the finish, all contributed to the slow adaptation of this process until these troublesome features could be eliminated.

Parkerizing

Messrs. Allen and Richards were mainly responsible for changes in the Coslett process, which made its present modification one of the most simple methods of rust prevention. Their patented modification in use today is known as "Parkerizing." The old Coslett solution was modified by the addition of an oxidizing agent such as MnO_2 to a 0.75 per cent solution of H_3PO_4 containing ferrous phosphate, this salt being partly oxidized to the ferric state after continued agitation and boiling. This last action is necessary to complete the partial oxidation of the ferrous salt, the correct proportion between the phosphates being 3 ferrous to 1 ferric. The formation of the coating, a basic ferroso-ferric phosphate, is similar in action to the Coslett reaction mentioned above. It has been found lately that part of the MnO_2 may be replaced by air, also that in the latter case the action of the MnO_2 can be considered as partly catalytic.[1] In the latter method of oxidation, the method of aëration presents a practical problem, since the finish of the work will be affected if the objects processed are of complicated form, and air be trapped and held in contact at any point.

Nature of Coating

The coating on iron or steel articles after removal from this phosphoric solution is of a uniform dark gray color, varying in intensity of shade according to the surfacing treatment the articles had previously received. In common with all chemical methods for metal coloring, the shadings obtained with phosphatic coatings are dependent on the previous treatment of the metal surfaces, such as sand blasting, tumbling, rubbing, etc. The choice of pickling solutions is also quite important. It is very interesting to note that while both the ferrous and ferric phosphates are light colored salts, the resulting ferroso-ferric phosphate is grayish black. There does not seem to be any definite formula for this compound; it may also be considered a mixture of basic phosphates. During the oxidation MnO_2 will break down to manganese phosphate, which also possesses rust-proofing qualities.

Processed materials, when dry, are dipped in a paraffine oil mixture, this treatment changing the dark gray coating to a deep black.

Phosphatic rust proofing is particularly adapted for the treatment of tools, typewriter parts, ordnance, motor parts, in fact for many things where rust should be prevented and an attractive finish is desired. In sub-

[1] See U. S. Pat. No. 1,248,053.

marine mine cases used during the war, it was found that barnacles would not adhere to them when previously rust proofed by the above methods. Articles can be processed partly assembled, as the size of the parts will not be affected. Another peculiar phenomenon exhibited by the phosphatic coatings is the stoppage or filling of pores in defective castings, the sealing of these fissures holding even when subjected to considerable pressure.

Equipment of Rust-Proofing Unit

The main equipment of a moderate-sized unit consists of one 1000-gal. air jacketed, steam-heated, welded tank, four 450-gal. wooden tanks, a sand tumbler, boiler, and oil draining pans. The four wooden tanks are arranged in line, somewhat as shown in Figs. 2 and 3, two being heated with steam coils, and the other two are used for rinsing with jets. These tanks contain the following solutions in the order named: Caustic cleaner, rinse, pickle, rinse. The steam inlets in the two rinsing tanks provide the circulation by condensation, outlets being at the top. A 30-hp. boiler should give sufficient steam without need of preheating the feed water.

It is important, when planning, to arrange the cleaning and processing tanks, sand tumblers and other units in routine order. An overhead track passing over the different tanks is necessary, preferably extended at the ends to stack accumulated work. The writer advises the use of a double set of chain hoists. This will facilitate the rapid transference of work, which is carried in this case in steel baskets containing perhaps 450 assembled metal stampings, weighing about 375 pounds. Transference work from wooden pickling baskets to steel ones for the acid dip could in certain cases be eliminated by using lead- or tin-coated steel baskets.

Concentrated H_3PO_4 solutions of ferrous phosphate, powdered MnO_2, the ordinary pickling acids, soda, potash, oil- and grease-removing cleaners, and dipping oil are the only materials used. The processing acid is supplied by the licensors of the process.

Operation of Process

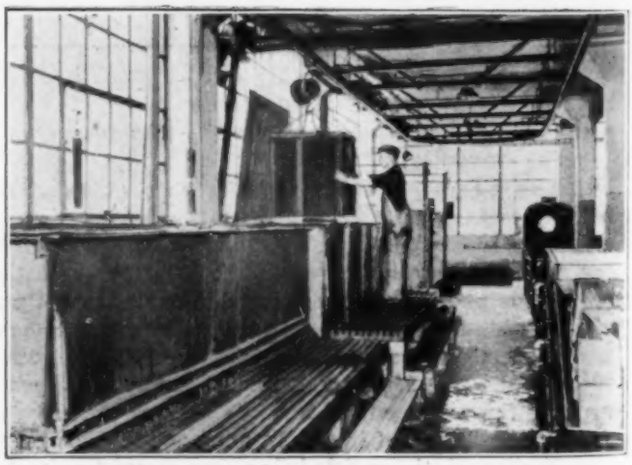
The iron or steel articles are freed from oil and grease by immersion for about twenty minutes in a solution of caustic soda or some patent cleaner—some of these cleaners easily removing mineral oils. Cleaning solutions should be over 200 deg. F. for best results. The work is now thoroughly rinsed in hot or boiling water, to dissolve any soaps formed in the cleaner, and when free of alkali passed into a 5 per cent H_2SO_4 pickle containing 1 oz. sodium bisulphite per gal. The decomposition of this salt will liberate SO_2 and if the pickling solution is kept below 150 deg. F., the SO_2 will be retained in sufficient quantity to act upon the work being cleaned. Black scale often present on iron, mainly Fe_3O_4, is quite insoluble, and can only be removed by excessive pickling, which is destructive to assembled or riveted work. The dissolved SO_2 will partly reduce the black scale to lower oxides, consequently facilitating solution and cleaning the metallic surfaces. When clean, which requires about 20 min., the work is again thoroughly rinsed in boiling water, to remove all acid and iron sulphates, then dried, sand tumbled or rubbed, and passed into the phosphate tank.

It is essential at this point that all articles be free from any adhering sulphates, as this radical is harmful to the phosphate solution. Some will always remain on the work, particularly when many parts are massed and treated together, and the last traces must be removed by rubbing or tumbling with sand. Sulphates not only affect the action of the rust-proofing solution but cause the formation of a rough, glistening coating. This is a coarse crystalline phosphate of iron, apparently growing from nuclei at points previously covered with sulphates. The size of the surface crystals seems to depend not only on the amount of metallic sulphate present, but upon unequal acidity over the surfaces of the object treated.

The writer has been able to eliminate the troublesome sanding operation in certain cases where the objects were of a shape permitting easy draining. After leaving the pickle the parts were immersed in limewater, and the precipitated calcium sulphate removed by agitation in a hot-water rinse. When this procedure is possible much time can be saved. It is a point where further development is possible, and a closer study of the effect of the different pickling acids on the processing solution and finish is necessary.

When metal is free from rust or scale, it can be sent to the phosphoric tank immediately after removing the grease and oil if a sand rub be substituted for the pickle. Clean, newly machined parts and stampings can be treated this way, the oil being removed with an organic solvent such as carbon tetrachloride. Unless the previous treatment of the steel or iron is known, this last procedure is not recommended.

When clean the work is transferred from the wooden crates used for pickling to steel baskets used in the rust-



FIGS. 2 AND 3. AN INSTALLATION OF 10-TON DAILY CAPACITY

proofing bath. When the sulphates are removed by lime-water the time consumed in transferring the articles can be saved by using lead coated baskets of the largest possible mesh.

Processing solution is made by mixing the phosphoric acid-iron phosphate mixture (sold under the trade name "Hyroacid") and manganese dioxide in the proportions

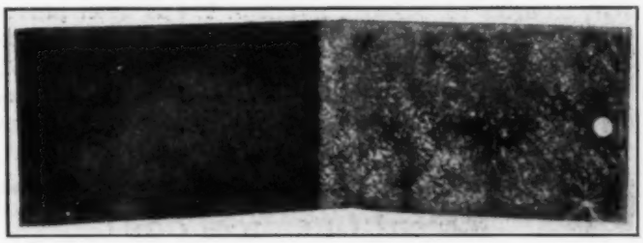


FIG. 4. EXPOSURE TEST OF SHEET PARTLY COVERED WITH PHOSPHATIC COVERING

of 4 pints acid and 2 lb. MnO_2 to each gallon of water, thoroughly mixing and boiling. Prolonged boiling for 12 hours is necessary when the solution is first made up, to insure the correlation of the different variables, such as acidity, ferrous and ferric iron. Continuous circulation of the solution is effected by proper construction of the tank, which should be provided with side heating coils and deflection vanes. Sludge forming from MnO_2 after the tank has been in use for some time is prevented from coming in contact with the work by baffle plates placed a certain distance from the bottom of the tank.

The articles are immersed from one to two and a half hours at 210 to 212 deg. F. When the evolution of hydrogen has ceased, the work is removed, dried, dipped in a paraffine oil mixture, and set in racks or pans to drain. Between batches it is advisable to boil the solution for an hour or two, as this improves its action.

Care must be taken to place the work so that it presents the least resistance to the flow induced by the heating coils and vanes in the tank.

Chemical Control

Ten cc. of the rust-proofing solution should be equivalent to 14.5 cc. N/10 NaOH for good results. Acidity running up to 18 cc. N/10 NaOH is not harmful, but higher amounts will have a pickling action on the work.

Twenty-five cc. of the solution should contain from 0.0236 to 0.0335 g. ferrous iron, and from 0.0019 to 0.00559 ferric iron. This is titrated with N/10 $KMnO_4$ in the usual manner—for more accurate readings N/20 $KMnO_4$ should be used. Correct correlation of acidity, ferrous and ferric iron is essential, and must be closely watched and controlled.

For convenience in operation, the acidity of the rust-proofing bath is expressed in "points of strength," 1 cc. N/10 NaOH being taken as one point. The depletion of the solution after each batch of work is coated will vary slightly from one to two and one-half "points." Acid and MnO_2 are added, the amounts and proportions per gallon given above being equivalent to one point of strength.

Results of Phosphatizing

Objects of iron and steel treated by the above process are very resistant to rust, withstanding exposure, saline atmospheres or laboratory fumes to a large degree, and testing very satisfactorily under the salt spray.[2] (See Fig. 4.)

Iron and steel protected with phosphatic coatings are not so resistant to wear and abuse as sherardized or galvanized metal. Surfacings composed mainly of Fe_3O_4 produced by the Bower-Barff and similar processes are more resistant to acids and bluer in color. However, phosphatic rust proofing is considerably cheaper than any other well known rust-proofing process in use today, the simplicity of treatment and uniformity being important factors in its favor.

New York, N. Y.

Synopsis of Recent Chemical and Metallurgical Literature

War-Time Ferrous Metallurgy in Germany.—In the *Iron and Coal Trades Review* for Sept. 12 and 19, 1919, are printed abstracts of reports of the Commission appointed to examine the iron and steel works in the war zone. They present a good review of the present status of the steel plants in Lorraine, Belgium, France, Luxemburg, and the occupied portions of Germany. A significant quotation regarding the metallurgical practice in the works under control of the Central Empires follows:

"A remarkable ingenuity was displayed in German works by the technical and engineering staffs in devising substitutes for materials which were unobtainable owing to war conditions. Thus the deficiency in manganese ores was partly made up by the use of low-grade manganese ores and old manganiferous slags. The slags from the Westphalian blast-furnaces contained as much as 14 per cent of manganese, a large part of which could be recovered by re-smelting. The process was wasteful of fuel, and would not be profitable in normal circumstances, but in the emergency which arose this source of manganese proved to be most valuable. Calcium carbide was also substituted in some cases for ferromanganese in the manufacture of steel. But no evidence was forthcoming of any important technical developments in iron- and steel-making during the war; nor did the Commission find evidence of any large extensions to works having been made. The production of iron and steel in Germany being largely in excess of normal requirements in peace time, there was a sufficiency of output to meet war demands without any great extensions, such as were necessary in England. Indeed, when war broke out, it was at first impossible to dispose of the whole German production of steel, and a number of furnaces were put out. At a later stage of the war, when the demand for munition steel became pressing, the then existing shortage of labor made it difficult to meet this demand by the ordinary methods, and the difficulty was met to a considerable extent by the melting down of scrap obtained in great quantity by breaking up machinery and plants in the Belgian and French areas under German occupation. The breaking up of valuable machinery and plants in Belgian and French works, however, served another purpose, namely, the removal of competition in the years immediately following the conclusion of peace; and that this was the main object aimed at was evidenced by the systematic way in which in most cases

[2]General Electric Bulletin, No. 48.926.

the most vital parts of the plant were selected for destruction, even when large quantities of easily accessible material were available in other parts of the works."

Hydrogen in the Ozone Form.—Closely allied to the practical work which has been carried on during the last two years in the reduction of gases of the atmosphere, oxygen, nitrogen and helium, and the manufacture of hydrogen and ozone, the more recent research and study of Prof. GERALD L. WENDT, of Chicago University, on the ozone form of hydrogen proves most interesting. Detailed accounts of his research are printed in the *Proceedings* of the American Academy as well as those of the American Chemical Society. The following paragraphs cover a brief abstract of the more complete report.

It is believed that hydrogen atoms, although possessed of single valences, unite to form a molecule of a weight 3, with seemingly the same relation to the hydrogen molecule as ozone has to the oxygen molecule. The active qualities of this new form differ from those of atomic hydrogen.

This is without doubt the same gas discovered to be present in a hydrogen discharge tube by Sir J. J. Thompson in 1912 and called by him X_3. In his experiments he found it combined with oxygen under action of light, was destroyed by sparking with oxygen or heating with copper oxide. It stood high temperatures without disintegration. No new spectrum was obtained with it.

Dr. Wendt, working with William Duane,[1] in 1914, produced chemically active hydrogen with alpha rays from radium, accompanied by a distinct contraction of the gas. The new gas formed H_2S with sulphur; reduced neutral permanganate solution to give manganese dioxide precipitate; decolorized acid permanganate, giving a manganous salt; reduced arsenic to arsine and phosphorus to phosphine; and gave a yellow compound with metallic mercury, probably a hydride, which decomposed on heating. Separation by an electrostatic field, 1000 volts per cm., proved these activities were not due to charged molecules or ions. The active gas is unstable, breaking down to the inactive molecule in a few minutes. In a temperature of liquid air the activity is destroyed either by condensation or disintegration to ordinary H_2.

The recent work of Lind[2] and Usher,[3] the latter in Ramsay's laboratory, has confirmed that the molecule of this gas is larger than H_2. Langmuir[4] has prepared an active form of monatomic hydrogen which is distinct from H_2 in that it will not pass through a plug of glass wool, being strongly adsorbed, and in that it does not exist except at the very highest vacua. The ozone form will on the contrary pass through long layers of glass wool and exists for some time at atmospheric pressure.

J. J. Thompson[5] by photographic method and Dempster[6] by electrical measurement have both shown the presence of H_3 in a tube of H_2 under electric discharge at high vacuum, and at pressures of 0.05 mm. the latter has shown that H_3 predominates.

Dr. Wendt makes this ozone form of hydrogen by passing ordinary H_2 through a Geissler tube. The absence of hydrogen ions in the product is shown by passing through a sensitive emanation electroscope. This is done over a period of many hours where the instrument is sensitive to the detection of 10 to 12 curie of radium emanation, with ease, and no ions are evidenced.

The H_3 molecule is not in accordance with the present theories of valence, although it has been proved consistent with Bohr's model of the hydrogen atom. "Indeed," as Prof. Wendt says, "it is probably only the injunction due to the valence theory which has prevented the observation of this variety of hydrogen at a much earlier time than the present."

[1]Duane and Wendt, *Physical Review*, vol. 10, pp. 116-128 (1917).
[2]S. C. Lind, *J. Am. Chem. Soc.*, vol. 41, p. 545 (1919).
[3]F. L. Usher, *J. Chem. Soc.*, vol. 97, p. 400 (1909).
[4]Irving Langmuir, *J. Am. Chem. Soc.*, vol. 34, pp. 860, 1310 (1912); vol. 36, p. 1708 (1914); vol. 37, p. 417 (1915).
[5]Rays of Positive Electricity, Longmans (1919).
[6]A. J. Dempster, *Phil. Mag.*, vol. 31, pp. 438-443 (1916).

Recent Chemical and Metallurgical Patents

Australian Patents

Complete specifications of Australian patents may be ordered from the Government Printer, Melbourne, one shilling each.

Recovering Fats and Oils.—To recover fats and oils from trade waste liquors, the saponaceous products are broken up by chlorine without agitation, the fatty matter being liberated from the alkaline base. The liquors are allowed to settle and then removed to another tank, where chlorine is forced into the inflowing stream by means of a jet of compressed air. (Australian Patent 6886, A. J. DE BAEVE, New South Wales; April 15, 1919.)

Electrodeposition of Zinc.—To minimize the deleterious effect of small quantities of cobalt in a zinc sulphate electrolyte, glue is added to the liquid either before or after passing into the cells. (Australian Patent 7190, R. H. STEVENS; assigned to Electrolytic Zinc Co. of Australasia Proprietary, Ltd., Tasmania; May 6, 1919.)

Dissolving and Breaking Down Shellac.—To prepare a solution of shellac for stiffening felt hats and like purposes, 4 lb. of soda is dissolved in 4 gal. of water in a steam-jacketed pan, after which 5 lb. of resin and 20 lb. of shellac are successively added and the mixture is gently boiled for 2 or 3 hours. Six lb. of salt and 3 lb. of soda each dissolved in 3 gal. of water are then added to the mixture, which is finally boiled for 2 hours. This mixture may be broken down by slowly stirring in 8 or 10 gal. of cold water, and for treating soft felt hats 1 lb. of linseed oil is substituted for the resin, while for hard felt hats about 10 lb. of resin may be used. (Australian Patent 7624, T. MACKENZIE, South Australia; May 6, 1919.)

Liquid Fuel.—To manufacture a liquid fuel which is suitable for internal combustion engines, alcohol is partially etherealized by making it bubble, at a temperature of distillation of 100 to 150 deg. C., through a mixture consisting of 9 parts of sulphuric acid and 5 parts of alcohol. The resultant distillate is rectified and mixed with 10 to 40 per cent of alcohol and 5 to 50 per cent of a suitable hydrocarbon oil to produce a fuel mixture having a specific gravity of 0.730 to 0.780. (Australian Patent 8816, A. DE FEO LOPEZ, Argentina; June 10, 1919.)

Manufacturing Oil Pastes.—To obviate drying the material when preparing oil pastes, such as white

lead from lead precipitates, a predetermined quantity of borate of manganese, not exceeding 0.5 per cent, is added to the wet precipitate, after which oil is added and the mass is subjected to thorough mechanical working and mixing to expel the water and cause the oil to combine with the precipitate. (Australian Patent 8323, H. P. FLETCHER, New South Wales; July 8, 1919.)

Paint for Tropical Climates.—A paint which consists of 43.5 parts of precipitated lead carbonate, 6.5 parts of finely powdered dolomite, 36.5 parts of precipitated zinc hydroxide, 3 parts of infusorial earth, 4 parts of finely precipitated aluminum hydroxide, 0.5 parts of cobalt acetate, and 6 parts of precipitated calcium sulphate, which are dehydrated and mixed with 6 parts of polymerized linseed oil, 4 parts of refined perilla oil, 6.5 parts of refined linseed oil, and 1.5 parts of Chinese tung oil. (Australian Patent 8833, E. MAJOR and J. A. MAJOR, New South Wales; July 22, 1919.)

Hydrocarbon Cement.—A cement for building, paving, etc., in which pitch, tar, or other aromatic hydrocarbon having a specific gravity of not less than 1.1 is brought to a temperature of 120 to 180 deg. C., and mixed with from one to four times its volume of powdered metallic sulphates, such as calcium or magnesium sulphate. In a modification, the mixture is formed under pressure in a closed vessel to raise the boiling temperature, the volatile matter produced being utilized as fuel for the process. (Australian Patent 7487, W. S. BARRIE and L. CHADWICK, Queensland; July 29, 1919.)

Canadian Patents

For full specification address Commissioner of Patents, Ottawa, Canada

Leather Manufacture.—A process of treating leather which consists in covering the leather with a thin coating of oil heated to a temperature of approximately 150 deg. F., then allowing the oil to remain in contact with the leather for approximately 12 hours and until the temperature of the leather has cooled to approximately 80 deg. F., then applying a second coating of oil heated to approximately 150 deg. F., and again allowing the leather and oil to remain in contact and cool to a temperature of approximately 80 deg. F. for another 12-hr. period, and repeating the alternate heating and cooling processes until 5 or 6 coatings have been applied. (Canadian Patent 189,958, ALFRED J. HAWKINS, Montreal, Quebec; April 29, 1919.)

Potassium Extraction.—A process of producing a soluble salt of an alkali metal, which consists in treating a silicate containing said metal with uncombined phosphoric acid, thereby producing a double phosphate of said alkali metal, and an insoluble residue consisting only of constituents of the original silicate, separating said alkali phosphate from the insoluble residue, adding an acid which will replace the phosphoric acid in the salt, thus converting the alkali metal phosphate into the alkali metal salt of the other acid and freeing the phosphoric acid, and crystallizing the alkali metal salt of the added acid from the phosphoric acid and utilizing the recovered phosphoric acid to react upon fresh mineral containing said alkali metal. (Canadian Patent 191,260, FREDERICK D. S. ROBERTSON, Toronto, Ontario; July 1, 1919.)

Book Reviews

THE YEAR BOOK OF THE COKE OVEN MANAGERS' ASSOCIATION. 482 pp., including 169 pp. of tables and miscellaneous general information. London: Benn Bros., Ltd. Printed for private circulation only.

This year book is very creditable to the young British organization whose activities it records, especially considering the extraordinarily difficult conditions existing during the year 1918, which was the second year of the association's existence. The book includes 30 articles on subjects relating to by-product coking, of which 14 articles are printed in full, while the others are reported from various association addresses in the easy and interesting third person style so familiar in British publications. One-third of the book is taken up with mathematical, physical, and chemical tables and miscellaneous general information, even to the extent of income tax notes, all of which will undoubtedly make the volume useful as a handbook to the majority of its subscribers. Probably it is not intended to reproduce this material in subsequent annual issues. Naturally, most of the articles have reference to conditions resulting from the exigencies of the war, and many bear evidence of haste in preparation, which is surely pardonable under the circumstances. The recovery of benzol seems to have occupied the foreground in the meetings and discussions, for eight of the articles deal with various phases of this subject. In the reviewer's opinion, however, none of these articles gives new information of interest to American readers. In particular, the laboratory methods for the determination and testing of the benzols that have been developed on this side of the Atlantic have many points of advantage and superiority over those described in the year book.

Closely allied to the subject of benzol is that of the constituents of coal tar, to which two interesting articles are devoted. The first is a modified translation of Weger's paper "Uber Seltenere und Reinpräparate aus Steinkohlteer" (*Zeit. angew. Chem.*, XXII, I, pp. 338, 391). The translation has been modified and supplemented by Dr. P. S. Spielmann, so that it makes an admirable synopsis of practical information on the coal-tar substances. The second is a short report of a descriptive address by Dr. P. P. Bedson on "Coal-Tar Derivatives," dealing with general economic conditions, with examples of results of research in this industry. Ammonia recovery was the subject of discussion at three or four meetings, one of the most interesting addresses being made by Mr. E. Kilburn Scott on the "Manufacture of Ammonium Nitrate in Coke Oven Plants." In Mr. Scott's opinion, by-product coke plants can readily and profitably undertake the manufacture of nitric acid from a part of the ammonia which they produce and would thereby be enabled to convert all of their ammonia into ammonium nitrate.

Of special interest is the information given at several meetings relating to the use of coke-oven gas in gas engines, an important application with which American engineers have had comparatively little experience. Among other articles of technical interest are several on the subject of refractory materials used in coke-oven construction; a paper on the "Occurrences in the Oven During Carbonization," by D. V. Hollingworth; a report of Mr. E. M. Meyer's paper on the "Design and Layout of a Modern Coke Plant," and discussions of Boiler Feed Water, Coal Washing, and the Utilization of Low-Grade Fuels.

Of statistical importance is a complete list of by-product coke-oven plants in Great Britain, giving the name and address of each concern, the number and type of ovens, the by-products recovered, and the name of the coke-oven manager.

It is interesting and gratifying to note that the two principal themes that run consistently through the majority of addresses and discussions are appreciation of the importance of the chemist in the industry and consideration

of ways and means for the organized improvement of the industry. In all discussions of the second theme, the first is recognized as being closely related and fundamentally necessary. The Coke Oven Managers' Association is to be congratulated on the broad-minded and far-seeing attitude which is maintained in considering the general problems of the industry.

F. W. SPERR, JR.

Personal

Mr. HAROLD ADAMS, who was formerly production manager of the New York plant of E. R. Squibb & Sons, has resigned to accept a position with the research laboratory of the U. S. Rubber Co., Waterbury, Conn.

Col. F. J. M. AULD, of the British Army, has resigned his position as professor of chemistry at Reading and is now with the research laboratory of the Anglo-Persian Oil Co., 15 St. Phillips Road, Surbiton, Surrey, England. Col. Auld will be remembered by many of the men in the service who came in contact with him while he was chief of the British Chemical Warfare Mission at Washington, for his pleasing personality and his thorough knowledge of matters pertaining to gas warfare. Col. Auld has recently received the Distinguished Service Medal from Gen. Pershing and was awarded the Order of the British Empire and a Brevet by his own government. The company with which he has now associated himself is building a large refinery in Wales.

Dr. EDWARD BARTOW, formerly Lieutenant-Colonel in the Sanitary Corps, connected with the Water Supply Service of the A. E. F., has resumed his former work as chief of the Illinois Water Survey Division.

Mr. BERRY V. BUSH, formerly head of the chemistry department at Friends Central School, Philadelphia, has been appointed research chemist in the organic research laboratory of the Eastman Kodak Co., Rochester, N. Y.

Mr. H. E. CLEAVES is now with the Charleston Chemical Co., Charleston, W. Va., as chief chemist, having left the Metal & Thermit Corp., Jersey City, N. J.

Mr. H. W. CURRY recently resigned from the Ozark Smelting & Mining Co., Coffeyville, Kan., to accept a position in the oxide department of the American Zinc, Lead & Smelting Co., Hillsboro, Ill.

Dr. HARRY A. CURTIS, formerly in the Federal Nitrogen Research Laboratory, is now on the chemical faculty of the Northwestern University, Evanston, Ill.

Mr. ELLIOTT E. GEISINGER, formerly of the Pfaudler Co., is now connected with the Firestone Tire & Rubber Co., Akron, Ohio, as industrial engineer.

Mr. H. D. GIBBS has resigned as chemist in charge of the color laboratory of the U. S. Bureau of Chemistry to accept a research position with E. I. duPont de Nemours & Co., at its Jackson Laboratories, Wilmington, Del.

Mr. CHESTER G. GILBERT has resigned from the Smithsonian Institution to accept a position on the staff of Arthur D. Little, Inc., of Cambridge, Mass., which has opened a Washington office in the Munsey Building, with Mr. Gilbert in charge.

Dr. EDWARD S. JOHNSON, formerly with the Solvay Process Co., has accepted the position of director of manufacture and chief chemist of the U. S. Color & Chemical Co., with main office in Boston and plant at Ashland, Mass.

Mr. ROY G. KNICKERBOCKER has accepted the position of superintendent of erection and operation of a new smelter and refinery for the Messina Development Co. of Transvaal, South Africa.

Mr. J. A. LECLERC has resigned as chemist-in-charge of the laboratory of plant chemistry of the Bureau of Chemistry, Washington, D. C., to accept a position with the Miner-Hillard Milling Co., Wilkes-Barre, Pa.

Mr. J. R. LORENZ, formerly in the research laboratory of William F. Mosser Co., Chicago, Ill., is now with the Northeastern Leather Co., Salem, Mass., as tanning chemist.

Mr. W. H. MACMILLAN has resigned as chief chemist of the Remington Typewriter Co., Ilion, N. Y., to accept a position in the metallurgical laboratory of the Halcomb Steel Co., Syracuse, N. Y.

Mr. CHARLES A. MANN has been appointed professor of industrial chemistry, School of Chemistry, University of Minnesota, Minneapolis, Minn.

Prof. C. H. MATHEWSON has been elected professor of metallurgy and metallography in the Sheffield Scientific School of Yale University.

Dr. E. MILLER, associate in chemistry at Johns Hopkins University, has resigned to take a position with the duPont Powder Co.

Mr. NORVILLE C. PERVIER, recently discharged from the U. S. Army, has returned to his former position as chief chemist of the Standard Chemical Company, Inc., Des Moines, Iowa.

Dr. A. PIRELLI has been elected president of an Italian Society of Chemical Industry which has been organized at Milan.

Dr. ARTHUR B. RAY, recently Captain in the Chemical Warfare Service, has joined the staff of the research laboratories of the National Carbon Co., Inc., Cleveland, Ohio.

Mr. R. C. SHUEY has resigned as assistant superintendent of Armour Soap Works to go into the engineering department of the Redmanol Chemical Products Co., Chicago, Ill.

Mr. ALFRED H. WHITE, formerly Lieutenant-Colonel and chief of the research section of the Nitrate Division of the Ordnance Department, has returned to his former position as professor of chemical engineering at the University of Michigan, but is retaining connection with the nitrogen fixation work as consulting engineer of the Ordnance Department.

Current Market Reports

The Non-Ferrous Metal Market

New York, Dec. 29:—The copper market has gained both in strength and in activity during the last week. Tin is practically the same in price. A steady demand for lead has stiffened the price.

	Cents Per Lb.
Copper, electrolytic	18.75
Aluminum, 98 to 99 per cent	33.00
Antimony, wholesale lots	9.75
Nickel, ordinary	42.00
Nickel, electrolytic	45.00
Tin, Straits, spot	53.25
Lead, New York, spot	7.50
Lead, E. St. Louis, spot	7.20
Silver (Dollars per oz.)	1.33½

FINISHED METAL PRODUCTS

	Warehouse Prices Cents Per Lb.
Copper sheets, hot rolled	28.50
Copper sheets, cold rolled (over 14 oz.)	30.50
Copper bottoms	37.00
Copper rods	29.50
High brass wire and sheets	25.50
High brass rods	24.24
Low brass wire and sheets	28.25
Low brass rods	28.25
Brazed brass tubing	37.25
Brazed bronze tubing	42.00
Seamless copper tubing	32.00
Seamless bronze tubing	36.00
Seamless brass tubing	30.50

SCRAP METALS

	Cents Per Lb.
Aluminum, cast scrap	22½ – 23½
Aluminum, sheet scrap	21½ – 22½
Aluminum clippings	24½ – 26
Copper, heavy machinery comp.	14½ – 14¾
Copper, heavy and wire	13¾ – 14
Copper, light and bottoms	12½ – 12¾
Copper, heavy cut and crucible	15½ – 16
Brass, heavy	7½ – 8½
Brass, casting	10½ – 10¾
Brass, light	5½ – 6½
No. 1 clean brass turnings	8½ – 8¾
No. 1 comp. turnings	11½ – 12
Tea lead	4.50 – 4.60
Lead, heavy	5.76 – 5.87
Zinc, scrap	4½ – 4¾

The Iron and Steel Market

Coal shortage is still a factor in restricting steel mill operations, but not to the extent of keeping operations below the rate obtaining just before the coal shortage developed. Rather the difficulty is that some of the capacity which the practical disappearance of the iron and steel strike would permit of being operated is held idle. On the whole there is considerably more capacity in operation now than when the coal shortage became a factor early in December. Coke shortage is as much of a factor in restricting operation of blast-furnaces as coal shortage is in the case of steel mills. For illustration, both the Bellaire and Mingo works of the Carnegie Steel Co., in the Wheeling district, had been idle since Sept. 22 on account of the iron and steel strike, which held on longer in the Wheeling district than anywhere else, and last week the Mingo works started but the Bellaire works remained down from lack of coke, a condition that will probably be remedied this week.

Coke Output Increasing

The by-product ovens have been steadily increasing their coke output as coal supplies increased, through getting back to normal coking time. The Carnegie Steel Co. is now about to put in operation two new batteries of ovens at the Clairton plant, 64 ovens each, recently completed. The original plant of ten batteries, 640 ovens, was completed and put in operation before the end of last year. The plant eventually is to comprise 20 batteries, the original plan having been to build ten batteries at the outset and the remaining ten at a considerably later time, but during the war two batteries of the last ten were set forward on the program. Apart from the plant of the Pittsburgh Crucible Steel Co., to be completed next summer, there is scarcely any construction of by-product ovens in progress. It is estimated that by-product ovens, in batteries of 50 to 100, would cost about $45,000 per oven, while the iron and steel industry cannot think of such new construction, apart from the item of cost, as long as it has not sufficient labor to operate in full its various existing facilities.

Market Quiet

The pig iron, unfinished steel and finished steel markets have been quiet for a week or ten days, making a sharp contrast with the feverish activity that has prevailed for two months or more. The quietness is the natural and invariable thing for the holiday season, but at the same time it is the unbroken experience of the past that after a "holiday dullness" the markets do not automatically resume their activity, fresh-compelling influences being requisite. Markets are not purely the resultant of statistics or the relation between supplies and requirements, but are distinctly affected by psychological influences. In the case of pig iron, with its advance of $10 to $12 a ton since last June, chiefly in the past few weeks, it may even be found that there was something more than normal psychology, possibly a little of "mob psychology" or the psychology of the crowd. The past week is the first for two months or more in which no noteworthy advances in pig iron have occurred. Declines in the near future, however, are probably out of the question, for all furnaces are sold up for several months ahead and would have no occasion to cut prices even if demand were extremely light. In the eastern Pennsylvania and Buffalo districts there was considerable buying by speculative interests and there is always a possibility of speculators endeavoring to unload at unsuitable times.

Premiums for Steel

While the finished steel markets have been much quieter in the past week, greater delivery premiums have been paid in a number of instances. A fortnight ago plates for early delivery were in general at about 2.75c., higher prices being paid only on very small lots, but two or three lots in tonnages running into four figures have lately been sold at 3c. The Carnegie Steel Co. has again bid 2.50c. on plates for the Navy Department, the lot now in negotiation being 10,000 tons. The March 21 or "stabilized" price is 2.65c., and the Steel Corporation does not in any instance ask more. Some large independents are quoting 2.75c. even for late deliveries, while prices above that are for very early deliveries only. Steel bars in small lots have been bringing as high as 3c., the regular price being 2.35c., but some relatively conservative interests are on a 2.50c. basis, despite the adherence of the Steel Corporation and some independents to the 2.35c. price. Sheets, both black and galvanized, have been done at $10 premium for first quarter.

The Chemical Market

New York, December 26, 1919.

A perspective of the current year's market shows great activity among users of chemicals and a mighty effort on the part of the producer to meet this increased demand of a post-war period. Among the primary causes of the present high scale of prices are the unsettled labor conditions, scarcity of raw materials and a lack of adequate transportation facilities.

The past week has been a period of resting before the take-off for the new year, all branches being quiet. *Salammoniac* remains firm at 12¼-14c. per lb., car lots, and 13¼-15½c. in less than car lots. There is some English salammoniac on the market at 11c. per lb., but it is the opinion of some that England will place an embargo on the exporting of this item to the United States owing to a scarcity of ammonia liquor. *Caustic soda* has jumped from $3.80 to $4.10-$4.35 per cwt., while *formaldehyde* is scarce at 20-37c. per lb. *Sodium bichromate* is easier with a new low mark of 22c., against 25c. per lb. of last week. Quotations on *alcohol* are unobtainable. There is a considerable supply of ethyl and denatured, but the prices being paid by the patent medicine men are prohibitive and drive off any other likely buyers. Further difficulties arise from the uncertainty as to the stand the Government will take regarding denatured alcohol. Some former distillers have put up large denaturing plants.

Dimethylaniline in the coal-tar products is active at 88-90c. per lb. compared with 60-92c. of the previous report. Japan at present is a heavy buyer of this item. *Aniline oil* has had considerable inquiry and is easier than last week, the low price dropping from 35c. to 34½c. per lb., drums included, while *aniline salts* is unobtainable, though quoted at 43-45c. The demand on *benzol*, pure water white, at 27-31c. per gal., *toluol* in tanks 28c. per gal., and *naphthalene* continues heavy, with prices firm.

Naval stores are firm, with a reported firmer Southern market; prices remain unaltered. The lack of cables from English and Indian markets due to the holiday season celebration leaves the same prices standing from last week in the *crude rubber* market. *Vegetable oils* have been dull caused by the buyers balking at the present scale of prices.

In the miscellaneous materials *barytes*, domestic white floated, is especially active at $35-$40 per ton, with the entire production filling domestic demand. *Fuller's earth*, domestic and imported, is unobtainable at present, with the nominal quotation of $25-$35 on the former and $35-$45 per ton on the latter still holding. *Domestic chalk*, extra light, claimed to be lighter than the imported extra light, is quoted at 5-5½c. per lb., while the light is being sold at 4½-5c.

Ferro-alloys are firm and quiet. Among the ores and semi-finished products *tungsten* has had some movement, owing to those who have this item stocked clearing their books; prices remain about the same.

Domestic producers of *ferromanganese*, after making fairly large sales at their advanced price of $120, delivered, have now advanced to $130, on which basis the market is quiet. English is now quoted at the advanced price of $125, c.i.f., but in the circumstances there would be little demand at that figure. *Spiegeleisen* is quoted at $40, furnace, for spot and $41 to $42 for futures.

Electric-furnace *ferrosilicon* is quiet at recently advanced prices, makers quoting $90 for 50 per cent and $140 to $150 for 75 per cent, delivered Pittsburgh, valley and Cleveland districts. Blast-furnace ferrosilicon is quiet, with the following prices ruling on bessemer ferrosilicon: 10 per cent, $59.50; 11 per cent, $62.80; 12 per cent, $66.10, f.o.b. Jackson, Ohio.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	.....	$0.60 -$0.65
Acetone	lb.	$0.20 -.....	.21 -.....
Acid, acetic, 28 per cent	cwt.	2.50 -$2.75	3.00 - 3.25
Acetic, 56 per cent	cwt.	5.00 - 5.50	6.00 - 6.50
Acetic, glacial, 99½ per cent, carboys	cwt.	13.00 -13.50	13.50-15.50
Boric, crystals	lb.	.15 - .15½	.15½- .16½
Boric, powder	lb.	.14½- .15	.15 - .16
Hydrochloric, (muriatic) tech. 20 deg.	cwt.	.... -	2.25 - 2.50
Hydrofluoric, 52 deg.	lb.	.12 -.....	.14 -.....
Lactic, 44 per cent. tech	lb.	.11 - .14	.12 - .16
Lactic, 22 per cent. tech	lb.	.05 - .06	.05½- .07
Molybdic, C. P.	lb.	..... -	4.00 - 4.25
Nitric, 40 deg.	lb.	.06 - .06½	.07 - .08½
Nitric, 42 deg.	lb.	.07 - .07½	.08 -.....
Oxalic, crystals	lb.	.30 - .31	.30 - .33
Phosphoric, Ortho, 50 per cent. solution	lb.	.09 -.....	.10 - .14
Picric	lb.	.30 - .35	.40 - .50
Pyrogallic, resublimed	lb.	..... -	2.30 - 2.60
Sulphuric, 60 deg., tank cars	ton	12.00 - 16.00	..... -.....
Sulphuric, 60 deg., drums	ton	17.00 -.....	22.00 -.....
Sulphuric, 60 deg., carboys	ton	20.00 -.....	25.00 -.....
Sulphuric, 66 deg., tank cars	ton	17.00 -18.00	22.00 -23.00
Sulphuric, 66 deg., drums	ton	20.00 -21.00	25.00 -26.00
Sulphuric, 66 deg., carboys	ton	25.00 -.....	30.00 -40.00
Sulphuric, fuming, 20 per cent. (oleum) tank cars	ton	20.00 -.....	26.00 -.....
Sulphuric, fuming, 20 per cent. (oleum) drums	ton	25.00 -.....	32.00 -.....
Sulphuric, fuming, 20 per cent. (oleum) carboys	ton	30.00 -.....	35.00 -.....
Tannic, U. S. P.	lb.	..... -.....	1.35 - 1.45
Tannic (tech.)	lb.	..... -.....	.42 - .55
Tartaric, crystals	lb.	..... -.....	.69 - .74
Tungstic, per lb. of WO	lb.	..... -.....	1.20 - 1.40
*Alcohol, Ethyl	gal.	4.80 - 4.95	5.50 -.....
*Alcohol, Methyl	gal.	1.30 -.....	1.33 - 1.38
*Alcohol, denatured, 188 proof	gal.	..... -.....	.80 - .82
*Alcohol, denatured, 190 proof	gal.	..... -.....	76 - .78
Alum, ammonia lump	lb.	.03½- .04½	.04½- .04¾
Alum, potash lump	lb.	.08 - .08½	.09 - .09½
Alum, chrome lump	lb.	.15 - .16	.18 - .20
Aluminum sulphate, commercial	lb.	.01½- .02	.02½- .02¾
Aluminum sulphate, iron free	lb.	.02½- .03	.03½- .03¾
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08½-.....	.09½- .10
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	..... -.....	.30 - .33
Ammonium carbonate, powder	lb.	.13 - .13½	.14 - .14½
Ammonium chloride, granular (white salammoniac)	lb.	.12½- .14	.13½- .15½
Ammonium chloride, granular (gray salammoniac)	lb.	.12 - .12½	.13 - .13½
Ammonium nitrate	lb.	.10 -.....	.11 - .12
Ammonium sulphate	lb.	.05 -.....	.06 -.....
Amyl acetate	gal.	..... -.....	3.65 - 3.75
Arsenic, oxide, lumps (white arsenic)	lb.	..... -.....	.09 - .09½
Arsenic, sulphide, powdered (red arsenic)	lb.	..... -.....	..... -.....
Barium chloride	ton	90.00 - 95.00	95.00 -100 00
Barium dioxide (peroxide)	lb	.22 -.....	.24 -.....
Barium nitrate	lb.	.09½- .10½	.11 - .12
Barium sulphate (precip.) (blanc fixe)	lb.	.03 - .03½	.03½- .04
Bleaching powder (see calcium hypochlorite)		..... -.....	..... -.....
Blue Vitriol (see copper sulphate)		..... -.....	..... -.....
Borax (see sodium borate)		..... -.....	..... -.....
Brimstone (see sulphur, roll)		..... -.....	..... -.....
Bromine	lb.	..... -.....	.65 - .75
Calcium acetate	cwt.	2.00 - 2.05	2.10 -.....
Calcium carbide	lb.	..... -.....	.04½- .05
Calcium chloride, fused, lump	ton	19.00 -25.00	30.00 -40.00
Calcium chloride, granulated	lb.	.01½- .01¾	.02 - .02½
Calcium hypochlorite (bleaching powder)	cwt.	..... -.....	2.75 - 3.75
Calcium peroxide	lb.	..... -.....	1.50 - 1.70
Calcium phosphate, monobasic	lb.	..... -.....	.02 - .03
Calcium sulphate, precipitated	lb.	..... -.....	.09 - .09½
Carbon bisulphide	lb.	.05½-	.06 -.....
Carbon tetrachloride, drums	lb.	.10 - .11	.12 - .14
Carbonyl chloride (phosgene)	lb.	..... -.....	.75 -.....
Caustic potash (see potassium hydroxide)		..... -.....	..... -.....
Caustic soda (see sodium hydroxide)		..... -.....	..... -.....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 - .05½	.08 -.....
Cobalt oxide	lb.	..... -.....	1.50 - 1.55
Copperas (see iron sulphate)		..... -.....	..... -.....
Copper carbonate, green precipitate	lb.	..... -.....	.28 - .31
Copper cyanide	lb.	..... -.....	.65 - .70
Copper sulphate, crystals	lb.	.08½- .08¾	.09 - .09½
Cream of tartar (see potassium bitartrate)		..... -.....	..... -.....
Epsom salt (see magnesium sulphate)		..... -.....	..... -.....
Formaldehyde, 40 per cent	lb.	..... -.....	.20 - .37
Glauber's salt (see sodium sulphate)		..... -.....	..... -.....
Glycerine	lb.	..... -.....	.24½- .26
Iodine, resublimed	lb.	..... -.....	4.50 -.....
Iron oxide, red	lb.	..... -.....	.03 - .20
Iron sulphate, (copperas)	cwt.	1.00 -.....	1.20 - 1.50
Lead acetate, normal	lb.	..... -.....	.15 - .16
Lead arsenate (paste)	lb.	..... -.....	.13 - .17
Lead nitrate, crystals	lb.	..... -.....	.85 - .86½
Litharge	lb.	..... -.....	.09½- .10½
Lithium Carbonate	lb.	..... -.....	.50 -.....
Magnesium carbonate, technical	lb.	..... -.....	.13 - .14½
Magnesium sulphate, U. S. P.	100 lb.	2.00 - 2.63	2.75 - 3.00
Magnesium sulphate, commercial	100 lb.	1.75 -.....	2.00 - 2.50
Nickel salt, double	lb.	.14 -.....	.15 -.....
Nickel salt, single	lb.	.12 -.....	.15 - .16
Phosgene (see carbonyl chloride)		..... -.....	..... -.....
Phosphorus, red	lb.	..... -.....	.75 - .90
Phosphorus, yellow	lb.	..... -.....	.35 - .37
Potassium bichromate	lb.	.26 - .27	.30 - .35
Potassium bitartrate (cream of Tartar)	lb.	..... -.....	.58 - .60
Potassium bromide, granular	lb.	..... -.....	.50 - .65
Potassium carbonate, U. S. P.	lb.	.60 -.....	.65 - .70
Potassium carbonate, crude	lb.	.29 -.....	.30 -.....
Potassium chlorate, crystals	lb.	.30 - .20	.21 - ...
Potassium cyanide, 98-99 per cent.	lb.	nominal	
Potassium hydroxide (caustic potash)	lb.	.28 - .32	.35 - .40
Potassium iodide	lb.	..... -.....	3.55 - 3.60
Potassium nitrate	lb.	.19 -.....	.21 -.....
Potassium permanganate	lb.	..... -.....	.55 - .65
Potassium prussiate, red	lb.	..... -.....	1.05 - 1.15
Potassium prussiate, yellow	lb.	..... -.....	$0.36 -$0.40
Potassium sulphate	ton	225.00 -.....	.....-.....
Rochelle salts (see sodium potas. tartrate)		.....-.....	.....-.....
Salammoniac (see ammonium chloride)		.....-.....	.....-.....
Sal soda (see sodium carbonate)		.....-.....	.....-.....
Salt cake (sodium sulphate)	ton	17.00 -21.00	.....-.....
Silver cyanide	os.	.....-	1.25 -.....
Silver nitrate	os.	.....-	81½- 82½
Soda ash, light	100 lb.	2.00 -.....	2.05- ...
Soda ash, dense	100 lb.	2.25 - 2.35	2.50 - 2.75
Sodium acetate	lb.	.05½- .06½	.07 - .08
Sodium bicarbonate	100 lb.	2.60 -.....	2.75 - 3.00
Sodium bichromate	lb.	.....-	.19 - .25
Sodium bisulphate (nitre cake)	ton	3.00 - 8.00	10.00 -.....
Sodium bisulphite	cwt.	1.80 - 1.90	2.00 - 2.10
Sodium borate (borax)	lb	.08 - .09	.09 - .10
Sodium carbonate (sal soda)	100 lb.	1.35 - 1.50	1.50 - 1.75
Sodium chlorate	lb.	.15 -.....	.16 - .18½
Sodium cyanide, 96-98 per cent.	lb.	.30 -.....	.31 - .34
Sodium fluoride	lb.	.14 -.....	.15 - .16
Sodium hydroxide (caustic soda)	100 lb.	.....-.....	4.10 - 4.35
Sodium molybdate	lb.	2.50 -.....	3.25 -.....
Sodium nitrate	100 lb.	.....- 3.25	3.75 - 4.00
Sodium nitrite	lb.	.15 - .17	..... - .18
Sodium peroxide, powdered	lb.	.....-.....	.30 - .32
Sodium phosphate, dibasic	lb.	.03½- .04	.04½- .05
Sodium potassium tartrate (Rochelle salts)	lb.	.....-.....	.43 - .45½
Sodium prussiate, yellow	lb.	.23 - .24	.24 - .25
Sodium silicate, solution (40 deg.)	lb.	.01½- .02	.02 - .02½
Sodium silicate, solution (60 deg.)	lb.	.02½- .03	.03½- .04½
Sodium sulphate, crystals (Glauber's salts)	cwt.	1.15 - 1.25	1.50 - 2 00
Sodium sulphide, crystal, 60-62 per cent. (conc)	lb.	.....-.....	.05 - .06
Sodium sulphite, crystals	lb.	.03½-.....	.04 - .06
Strontium nitrate, crystals	lb.	.25 -.....	.28 -.....
Sulphur chloride	lb.	.05½-.....	.06 -.....
Sulphur, crude	ton	22.00 -.....	.....-.....
Sulphur dioxide, liquid, cylinders	lb.	.....-.....	.10 - .12
Sulphur (sublimed), flour	100 lb.	3.10 -.....	3.40 - 3.65
Sulphur, roll (brimstone)	100 lb.	2.95 -.....	3.15 - 3.40
Tin bichloride (stannous)	lb.	.44 -.....	.46 - .50
Tin oxide	lb.	.....-.....	.60 -.....
Zinc carbonate, precipitate	lb.	.....-.....	.20 -.....
Zinc chloride, fused	lb.	.12½-.....	.13½- .14
Zinc cyanide	lb.	.49 -.....	.50 -.....
Zinc dust	lb.	.09 - .11	.11 - .14
Zinc oxide, dry American	lb.	.....-.....	.09½- .12
Zinc sulphate	lb.	.03½- .03¾	.04 - .04½

*Nominal quotations

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00 —	$1.10
Alpha naphthol, refined	lb.	1.40 —	1.50
Alpha naphthylamine	lb.	.32 —	.50
Aniline oil, drums extra	lb.	.35 —	.36
Aniline salts	lb.	.43 —	.45
Anthracine, 80% in drums (100 lb.)	lb.	.90 —	1.00
Benzaldehyde (f.f.c.)	lb.	1.00 —	1.15
Benzidine, base	lb.	1.10 —	.....
Benzidine, sulphate	lb.	.90 —	1.00
Benzoic acid, U. S. P.	lb.	.90 —	1.10
Benzoate of soda, U. S. P.	lb.	.80 —	1.00
Benzol, pure, water-white, in drums (100 lb.)	gal.	.27 —	.31
Benzol, 90%, in drums (100 lb.)	gal.	.25 —	.29
Benzyl chloride, 95-97%, refined	lb.	.35 —	.40
Benzyl chloride, tech	lb.	.25 —	.35
Beta naphthol benzoate	lb.	.50 —	.52
Beta naphthol, sublimed	lb.	.75 —	.80
Beta naphthol, tech	lb.	.45 —	.55
Beta naphthylamine, sublimed	lb.	2 25 —	2.35
Cresol, U. S. P., in drums (100 lb.)	lb.	.18 —	.....
Ortho-cresol, in drums (100 lb.)	lb.	.23 —	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	.80 —	.85
Cresylic acid, 95-97%, dark, in drums	gal.	.85 —	.90
Cresylic acid, 50%, first quality, drums	gal.	.60 —	.....
Dichlorbenzol	lb.	.07 —	.10
Diethylaniline	lb.	1.40 —	2.25
Dimethylaniline	lb.	.60 —	.92
Dinitrobenzol	lb.	.26 —	.37
Dinitroclorbenzol	lb.	.25 —	.30
Dinitronaphthaline	lb.	.45 —	.55
Dinitrophenol	lb.	.32 —	.36
Dinitrotoluol	lb.	.38 —	.45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 —	.65
Diphenylamine	lb.	.58 —	.75
H-acid	lb.	1.60 —	1.75
Metaphenylenediamine	lb.	1.15 —	1.80
Monochlorbenzol	lb.	.12 —	.15
Monoethylaniline	lb.	1.50 —	1.75
Naphthaline crushed, in bbls. (250 lb.)	lb.	.06 —	.08
Naphthaline, flake	lb.	.06½ —	.07½
Naphthaline, balls	lb.	.08½ —	.10
Naphthionic acid, crude	lb.	.75 —	1.25
Nitrobenzol	lb.	.14 —	.19
Nitro-naphthaline	lb.	.40 —	.45
Nitro-toluol	lb.	.27 —	.20
Ortho-amidophenol	lb.	3.00 —	4.25
Ortho-dichlor-benzol	lb.	.15 —	.20
Ortho-nitro-phenol	lb.	.90 —	1.25
Ortho-nitro-toluol	lb.	.25 —	.40
Ortho-toluidine	lb.	.25 —	.45
Para-amidophenol, base	lb.	2.50 —	3.50
Para-amidophenol, HCl	lb.	2.50 —	3.25
Para-dichlor-benzol	lb.	.15 —	.18
Paranitraniline	lb.	1.15 —	1.25
Para-nitro-toluol	lb.	1.35 —	1.50
Paraphenylenediamine	lb.	2.50 —	4.00
Paratoluidine	lb.	2.00 —	2.50
Phthalic anhydride	lb.	1.50 —	2.15
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12½ —	.16
Pyridin	gal.	2.00 —	2.50
Resorcin, technical	lb.	3.75 —	4.00
Resorcin, pure	lb.	6.50 —	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.45 —	.60
Salicylic acid, U. S. P.	lb.	.45 —	.50
Salol	lb.	.90 —	.95
Solvent naphtha, water-white, in drums, 100 gal	gal.	.22 —	.27
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19 —	.24
Sulphanilic acid, crude	lb	.25 —	.30

Tolidine	lb.	$1.70	—	$2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	.28	—	.....
Toluol, in drums	gal.	.32	—	.30
Xylidine, drums, 100 gal.	lb.	.44	—	.50
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal.	gal.	.37	—	.45
Xylol, commercial, in tank cars	gal.	.23	—	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow	lb.	$0.42	—	$0 44
Beeswax, refined, yellow	lb.	.47	—	.48
Beeswax, white pure	lb.	.63	—	.66
Carnauba, No. 1	lb.	.80	—	.83
Carnauba, No. 2, regular	lb.	.65	—	.78
Carnauba, No. 3, North Country	lb.	.44	—	.50
Japan	lb.	.18½	—	.20
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.06	—	.07
Paraffine waxes, crude, scale 124-126 m.p.	lb.	....	—	.06½
Paraffine waxes, refined, 118-120 m.p.	lb.	....	—	.09
Paraffine waxes, refined, 128-130 m.p.	lb	.09½	—	.10½
Paraffine waxes, refined, 133-135 m.p.	lb.	....	—	.12
Paraffine waxes, refined, 135-137 m.p.	lb.	....	—	.13
Stearic acid, single pressed	lb.	.23	—	.26
Stearic acid, double pressed	lb.	.28	—	.29
Stearic acid, triple pressed	lb.	.32	—	.33

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1 25		
Pine oil, pure, dest. dist.	gal.	1 00		
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.47		
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35		
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.65		
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.38		
Turpentine, crude, sp. gr., 0.900-0.970	gal	1.00		
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	....		
Pinewood creosote, ref.	gal.	.51		

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$17 00	—	$17.50
Rosin E-I	280 lb.	17.55	—	18.25
Rosin K-N	280 lb.	19.75	—	23.00
Rosin W. G.-W. W.	280 lb.	22.50	—	24.25
Wood rosin, bbl.	280 lb.	17.00	—	17.50
Spirits of turpentine	gal.	1.65	—	1.66
Wood turpentine, steam dist.	gal.	1.63	—	....
Wood turpentine, dest. dist.	gal.	1.50	—	....
Pine tar pitch, bbl.	200 lb.	8.25	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	—	14.90
Retort tar, bbl.	280 lb.	15 00	—	15.25
Rosin oil, first run	gal.	.86	—	.91
Rosin oil, second run	gal.	.88	—	.93
Rosin oil, third run	gal.	.95	—	1.12
Rosin oil, fourth run	gal.	1.05	—	1.15

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0 33½		
70-72 deg., steel bbls. (85 lb.)	gal.	.31½		
68-70 deg., steel bbls. (85 lb.)	gal.	.30½		
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½		

Crude Rubber

Para—Upriver fine	lb.	$0.53	—	$0.54
Upriver coarse	lb.	....	—	.35½
Upriver caucho ball	lb.	.34½	—	.35½
Plantation—First latex crepe	lb.	.51½	—	....
Ribbed smoked sheets	lb	.51½	—	....
Brown crepe, thin, clean	lb.	.46½	—	.47½
Amber crepe No. 1	lb.	.49	—	....

Oils

VEGETABLE

Unless otherwise noted, the following prices are f.o.b., New York.

Castor oil, No. 3, in bbls.	lb.	$0.18½	—	$0.19
Castor oil, AA, in bbls.	lb.	.21½	—	.22
China wood oil, in bbls.	lb.	.22½	—	.23
Cocoanut oil, Ceylon grade, in bbls.	lb.	.17½	—	.18½
Cocoanut oil, Cochin grade, in bbls.	lb.	.19½	—	.20
Corn oil, crude, in bbls.	lb.	.19	—	.21½
Cottonseed oil, crude (f.o.b. mill)	lb.	.18	—	.19
Cottonseed oil, summer yellow	lb.	.22	—	.27
Cottonseed oil, winter yellow	lb.	.23	—	.28
Linseed oil, raw, car lots	gal.	....	—	1.87
Linseed oil, raw, tank cars	gal.	1.80	—	1.83
Linseed oil, boiled, car lots	gal.	....	—	1.90
Olive oil, commercial	gal.	2.50	—	2.80
Palm, Lagos	lb.	.17	—	.17½
Palm, bright red	lb.	.16½	—	.17½
Palm, Niger	lb.	.16	—	.17½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.23½	—	.23½
Peanut oil, refined, in bbls.	lb.	.26	—	.28
Rapeseed oil, refined in bbls.	gal.	1.45	—	1.60
Rapeseed oil, blown, in bbls.	gal.	1.60	—	....
Soya bean oil (Manchurian), in bbls., N. Y.	lb.	.17½	—	.22
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.15½	—	.15½

FISH

Winter pressed Menhaden	gal.	$1.20	—	.....
Yellow bleached Menhaden	gal.	1.23	—	....
White bleached Menhaden	gal.	1.25	—	.....
Blown Menhaden	gal.	1.26	—	....

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$35.00	—	$40.00
Barytes, off color	ton	20.00	—	25.00
Blanc fixe, dry	lb.	.03½	—	.04½
Blanc fixe, pulp	ton	30.00	—	50.00
Casein	lb.	.16	—	.18
Chalk, English, light	lb.	.05	—	.07
Chalk, English, light	lb.	.04½	—	.06
Chalk, English, dense	lb.	$ .04	—	$ .05
China clay (Kaolin), imported, lump	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	ton	30.00	—	60.00
China clay (Kaolin), domestic, lump	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered	ton	25.00	—	40.00
Feldspar	ton	13.50	—	17.00
Fluorspar, acid grade, lump, f.o.b. mines	net ton	30.00	—	35.00
Fluorspar, acid grade, ground, f.o.b. mines	net ton	35.00	—	45.00
Fuller's earth, domestic, powdered	ton	25.00	—	30.00
Fuller's earth, imported, powdered	ton	35.00	—	40.00
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02½	—	....
Shellac, TN	lb.	1.10	—	1.15
Shellac, D. C.	lb.	.....	—	....
Shellac, V. S. O.	lb.	.....	—	....
Shellac, Diamond I.	lb.	.....	—	....
Shellac, orange, fine	lb.	1.25	—	.....
Shellac, orange, superfine	lb.	1.20	—	1.30
Shellac, A.C. garnet	lb	1.10	—	.....
Shellac, bleached, bone dry	lb.	1.35	—	.....
Shellac, bleached, fresh ground	lb.	1.10	—	1.15
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	16.00	—	60.00
Talc, imported	ton	60.00	—	70.00

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	80-90 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	1,000	35-45 at Clearfield, Penn.
Clay brick, 2nd quality	1,000	30-35 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-90 at Chester, Penn.
Silica brick	1,000	41-45 at Mt. Union, Penn.

Ferro-alloys

All prices f.o.b. works.

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.20	—	.40
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon	lb.	0.21	—	.50
Ferro-manganese, 70-80% Mn	gross ton	110.00	—	130.00
Spiegeleisen, 16-20% Mn	gross ton	33.00	—	45.00
Ferro-molydenum, per lb. of Mo	lb.	3.00	—	3.50
Ferro-silicon, 50%	gross ton	85.00	—	95.00
Ferro-silicon, 75%	gross ton	150.00	—	175.00
Ferro-silicon, 10-15%	gross ton	45.00	—	60.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	1.25	—	1.40
Ferro-uranium, 35-50%, of U	lb.	7.00	—	.....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	5.50	—	7.00

Ores and Semi-finished Products

Chrome ore, 35-40%, Cr_2O_3	unit	$0.60	—	$0.85
Chrome ore, 48% and over	unit	1.00	—	1.25
*Coke, foundry, f.o.b. ovens	net ton	7.00	—	7.50
*Coke, furnace, f.o.b. ovens	net ton	6.00	—	6.50
Petroleum coke, refinery, Atlantic seaboard	net ton	12.00	—	12.50
Fluorspar, gravel, f.o.b. mines	net ton	....	—	25.00
Manganese ore, 45% Mn and over	unit	.50	—	.75
Manganese ore, chemical (MnO_2)	gross ton	60.00	—	70.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	9.00	—	15.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	7.50	—	10.00
Uranium oxide, 96%	lb.	2.75	—	3.00
Vanadium pentoxide, 99%	lb.	6.00	—	.....
Pyrites, foreign, lump	unit	.17	—	.....
Pyrites, foreign, fine	unit	.17	—	.....
Pyrites, domestic, fine	unit	.16	—	.17½
Ilmenite, 52% TiO_2	lb.	.02	—	.....
Rutile, 95% TiO_2	lb.	.11	—	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	—	3.00
Zircon, washed, iron free	lb.	.10	—	.....
Monazite, per unit of ThO_2	unit	42.00	—	.....

* Government prices.

Plant Materials and Supplies

In carload lots, New York, unless otherwise stated.

BUILDING MATERIALS

Portland cement, at dock, without bags	bbl.	$2.80
Lump lime, common, including container	300 bbl.	2.65
Common brick, at dock	M.	16.00
Yellow pine, 3x4 to 8x8, 20 ft. and under	M.	48.00
Yellow pine, 3x4 to 8x8, 20 ft. and under at Chicago	M.	50.00
Yellow pine, 3x4 to 8x8, 20 ft. and under at St. Louis	M.	40.00
Roofings, tar felt (14 lb. per 100 sq.ft.)	ton	70.00
Roofings, tar pitch (in 400-lb. bbl.) carlots	ton	21.00
Roofings, asphalt pitch carlots	ton	34.00
Roofings, asphalt felt carlots	ton	63.00
Roofings, slate-surfaced, per roll of 108 sq.ft. carlots		2.25
Roofings, slate-finished shingles, 100 sq.ft. carlots		6.00
Linseed oil, raw in barrels	gal.	1.75
Linseed oil, 5 gal. cans	gal.	1.90
Red lead, dry, 100 lb. keg	lb.	.13
Red lead, in oil, 100 lb. keg	lb.	.14½
Red lead, dry, 5 lb. cans	lb.	.15
Red lead, in oil, 5 lb. cans	lb.	.16½
White lead, dry and in oil, 100 lb. keg	lb.	.13
White lead, dry and in oil, 25 and 50 lb kegs	lb.	.13½
White lead, dry and in oil, 5 lb. cans	lb.	.15

STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.66
Rivets, structural, ½-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ½-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.35
Sheets, No. 10 blue annealed	100 lb.	3.55
Sheets, No. 28 galvanized	100 lb.	5.70

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

California

EMERYVILLE (Oakland P. O.)—W. J. Miller, architect, 417 Market St., San Francisco, will soon receive bids for the construction of a 2-story factory, for the American Rubber Co., Emeryville. Estimated cost, $100,000.

LOS BANOS—The City Trustees have purchased the plant of the West San Joaquin Water Co. and plan to move same here and install tank, tower and filter in same.

Colorado

DENVER—The state plans to install an oil shale laboratory in the University of Colorado. Estimated cost, $20,000.

Connecticut

NAUGATUCK—Lockwood, Green & Co., architects, 101 Park Ave., New York City, will receive bids about Jan. 7 for the construction of a factory for the Naugatuck Chemical Co., c/o architects. Estimated cost, $70,000.

NEW BRITAIN—Landers, Frary & Clark (manufacturers of electric hardware), Commercial and Center Sts., have awarded the contract for the construction of 4 buildings, including a 3 story, 40 x 68 ft. tempering building, on South Standley St., to the Torrington Building Co., 197 Water St., Torrington. Estimated cost, $49,000.

Illinois

ALTON—The Illinois Glass Co. has purchased a plot at North Crawford and Wrightwood Aves., Chicago, and plans to build a new plant on same. Estimated cost, $250,000.

CHICAGO—The Channel Chemical Co., 58 East Washington St., has awarded the contract for the construction of a 4 story, 150 x 300-ft. factory on Western Ave. and West 45th St., to Davidson & Weiss, 53 West Jackson Blvd. Estimated cost, $450,000.

WHEATON—The city will soon receive bids for the construction of a sewage disposal plant, including filter beds. Estimated cost, $200,673. L. J. Ruddock, city engr.

Indiana

INDIANAPOLIS — The Van Briggle Chemical Co., 429 North Capitol Ave., plans to construct a 3-story, 160 x 200-ft. display and factory building at 16th St. and Capitol Ave. Estimated cost, $125,000. Charles E. Bacon, Merchants Bank Bldg., architect.

New Jersey

NEW BRUNSWICK—The city plans to issue $13,000 bonds for the installation of additional units at the filtration plant.

TRENTON—The International Gasofoam Co., 564 East State St., plans to build an oil plant here. Estimated cost, $50,000. L. E. Warren, Brokaw Bldg., New York City, interested.

Maryland

BALTIMORE—The American Sugar Refining Co., 117 Wall St., New York City, is having plans prepared for the construction of a sugar refining plant on Locust Pt. harbor front. Estimated cost, $8,000,000. Ralph Stubbs, general manager.

BALTIMORE—Louis Miller, 5 Lloyd St., will receive bids about Jan. 15 for the construction of a 2-story, 45 x 50-ft. dairy and cold storage building at 5-7-9 Lloyd St. Estimated cost, $50,000. G. R. Callis, Melvin Ave., Catonsville, architect.

CURTIS BAY—(Baltimore P. O.)—The Curtis Bay Copper & Iron Works will build a 1-story, 75 x 230-ft. addition to the structural iron and copper works plant on Beach St. Estimated cost, $100,000.

Michigan

NORTHVILLE—The Detroit Board of Health, 233 Antoine St., Detroit, plans to construct a 2-story, 28 x 36-ft. laboratory 2 miles north of here, in connection with the group of buildings to be constructed at the proposed Detroit Municipal Tuberculosis Sanitarium. Complete laboratory equipment will be installed in same. Stratton & Snyder, 1103 Union Trust Bldg., Detroit, architects.

Minnesota

DULUTH—The Minnesota Steel Co. has had plans prepared for the construction of an extension to the blast-furnace plant, here. Project includes 3 additional blast-furnaces, 14 open-hearth furnaces and a unit of 16 soaking-pit furnaces. Estimated cost, $10,000,000.

Ohio

BARBERTON—The Portage Rubber Co. is having plans prepared for the construction of an office building and power plant in the western section of the city. Estimated cost, $200,000.

CLEVELAND—Edward Stattuck, commissioner of purchases, city hall, received bids for the construction of a sewage disposal plant in the easterly section of the city, from the American Construction Co., Marion Bldg., $258,957; McHugh Bros., West 37th St., $338,730; Masters-Mullen Construction Co., Electric Bldg., $400,486. Plans include a laboratory, and a 140 x 142-ft. screen grit chamber building.

DAYTON—The Wuichet Fertilizer Co., Irwin St., has awarded the contract for the construction of a 2-story, 60 x 80-ft. and 60 x 110-ft. factory on Irwin St., to Joseph Lowes, Schwind Bldg. Estimated cost, $75,000.

NEWARK—The Parish Rubber Co. has awarded the contract for the construction of a 2-story, 110 x 180-ft. rubber factory to the Bellfontaine Steel Co., Bellfontaine. Estimated cost, $100,000.

Pennsylvania

WILKES-BARRE—J. Linn Johnson, Ross St., plans to construct a 2-story, 50 x 150-ft. machine and welding shop at Ross and Gildersleeve Sts. Estimated cost, $45,000.

Rhode Island

PROVIDENCE—The Gorham Manufacturing Co. (silversmith), Reservoir Ave., has awarded the contract for the construction of a 1-story, 30 x 120-ft. factory addition on Adelaide Ave., to J. W. Bishop Co., Foster St., Worcester. Esimated cost, $15,000.

Wisconsin

GREEN BAY—The John Hoberg Paper Co., Elm St., has purchased a site at 12th and Main Sts., and plans to build a 4-story, 60 x 250-ft. paper mill on same. Estimated cost, $250,000.

WAUWATOSA—Milwaukee county plans to construct an extension to the sewage disposal tank. Estimated cost, $30,000. The Board of Administration is in charge of the work. W. S. Shields, 1201 Hartford Bldg., Chicago, engineer.

Ontario

BARTON—The township has voted the Firestone Tire & Rubber Co., Firestone Park, Akron, Ohio, a fixed assessment as an inducement to the establishment of a tire factory here. The city of Hamilton has also passed a bylaw providing for a sewer and watering system to the proposed plant. Estimated cost, $1,500,000.

SUDBURY—The High School Board plans to construct a 3-story high school. Chemical and physical laboratories will be installed in same. Estimated cost, $200,000.

Coming Meetings and Events

THE AMERICAN CERAMIC SOCIETY will hold its annual meeting in Philadelphia, Pa., Feb. 23-26.

THE AMERICAN CHEMICAL SOCIETY will hold its annual meeting April 13 to 16 inclusive, in St. Louis.

THE AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Boston, April 8, 9, and 10.

THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York, Feb. 16-19.

THE NATIONAL FOREIGN TRADE CONVENTION will be held in San Francisco, May 12 to 15.

THE MINING AND METALLURGICAL SOCIETY OF AMERICA will hold a meeting in New York Jan. 13.

Industrial Notes

THE SPEARE CHEMICAL PRODUCTS CO., New York, has opened a branch office in Boston, Mass., at 27 School St., under the personal supervision of Mr. B. Goldstein.

THE OLIVER CONTINUOUS FILTER CO. announces the removal of its New York offices to the Aeolian Bldg. The rapidly increasing business of the company requires much larger space than it was able to obtain at the old quarters. Mr. Gordon Walker is in charge.

THE CROCKER-WHEELER CO., of Ampere, N. J., has just inaugurated a plan of training for its foremen and other factory supervisors which is of considerable interest. A group of 62 men has been formed to pursue a three months' course in modern production methods, which comprises the study of specially prepared text units, the solution of problems relating to the units, and the discussion of this material at six bi-weekly meetings held after hours in the plant. These meetings will provide an opportunity to bring home the application of the work to the special problems of Crocker-Wheeler Co. production. At each meeting a lecture will be delivered by an experienced production man and the lectures will be followed by a round-table discussion. Included in the group, besides foremen, are the superintendent and three assistant superintendents, which insures that the meetings will be highly resultful to the members of the class. The subjects to be studied are: How to promote team work in the shop; handling men in a way to increase production and promote harmony; how production should be organized; efficient purchasing, scheduling, routing, repairing, etc.; keeping down the overhead by stricter cost keeping; major problems of management. The course is under the direction of the Business Training Corporation of New York City, which supplies the study material and the class instruction.

Mr. EARL E. EBY, sales manager of the Hyatt Roller Bearing Co., has been appointed to the board of directors of HYATT, LTD., a new company formed to market the Hyatt bearings in Europe. Mr. Eby will devote his entire time to this work in New York City. Mr. G. M. Helmstaedter, formerly Chicago district manager, has been promoted to the position of sales manager to fill the vacancy formed by Mr. Eby's new duties.

New Publications

THE ORIFICE AS A MEANS OF MEASURING FLOW OF WATER THROUGH A PIPE. By Raymond E. Davis and Harvey H. Jordan. Bull. 109, Engineering Experiment Station, published by the University of Illinois, Urbana, Ill.

TRADING WITH AUSTRALASIA. Published by the Guaranty Trust Co. of New York.

CHEMICAL LITERATURE AND ITS USE. By Marion E. Sparks. Notes of twelve lectures in chemistry 92 required of third year students in chemistry and chemical engineering at the University of Illinois.

DESCRIPTIVE BULLETIN OF THE DEPARTMENT OF METALLURGICAL RESEARCH, State School of Mines, University of Utah. Published by the University of Utah, State School of Mines, in co-operation with the U. S. Bureau of Mines.

THE FABRIC OF CIVILIZATION. A short survey of the cotton industry in the United States. Published by the Guaranty Trust Co., of New York.

Programs of Exposition Week at Chicago

Fifth National Exposition of Chemical Industries.

Coliseum and First Regt. Armory

MONDAY, SEPT. 22

12 M.—Opening of Exposition.

2 P.M.—Meeting American Institute Mining & Metallurgical Engineers at Congress Hotel.

8 P.M.—Opening addresses at Chemical Exposition Auditorium. Gov. Frank O. Lowden of Illinois will make the address of welcome. Charles H. Herty, chairman of advisory committee, will respond. John W. O'Leary, president Metal Trades Association of Chicago, "The Relation of the Chemist to the Manufacturer."

9 P.M.—Motion pictures, in Chemical Exposition Auditorium.

TUESDAY, SEPT. 23

8 A.M.—Departure of members of the American Institute Mining & Metallurgical Engineers and American Electrochemical Society making excursion to steel mills at Gary, Ind.

2 P.M.—Symposium on "America's Case in Chemistry," at Chemical Exposition Auditorium, with Ellwood Hendrick, president Chemists' Club and consulting editor CHEM. & MET. ENG., as chairman. "Dyestuffs," by J. Merritt Matthews, editor *Color Trade Journal;* "Chemical Porcelain," by Herman S. Coors, of Herold China & Pottery Co.; "Laboratory Supplies; Lamp-Blown Glassware and General Apparatus," by C. G. Fischer, of Scientific Materials Co.; "Laboratory Supplies; Instruments of Precision," by J. M. Roberts, secretary Apparatus Makers' Association of U. S.; "Optical Glass," by Harvey N. Ott, of Spencer Lens Co.; "Glassware," E. C. Sullivan, of the Corning Glass Works; "Essential Metal Minerals" and "Pharmaceuticals" will likewise be spoken of.

8 P.M.—Motion pictures in Chemical Exposition Auditorium: "History and Utilization of Coal": 1. "The Story of Coal" (4 reels), accompanied by discussion by M. F. Leopold, of U. S. Bureau of Mines. 2. "The Manufacture of Beehive Coke" (1 reel). 3. "By-Product Coking With Koppers Ovens" (3 reels), (Courtesy The Koppers Co.). Joint Technical Meeting of American Institute of Mining & Metallurgical Engineers and American Electrochemical Society, on subject of "Iron and Steel" at Congress Hotel.

WEDNESDAY, SEPT. 24

10 A.M.—Meeting at Chemical Exposition of American Electrochemical Society for reading and discussion of papers. Registration and meeting at Chemical Exposition of Technical Association of Pulp and Paper Industry in Officers Room, First Regiment Armory; Address of welcome. Opening address by president. Report of executive committee. Report of secretary-treasurer. Reports by standing committees. Meeting at Chemical Exposition of American Ceramic Society.

12:30 P.M.—Adjournment for luncheon of all societies and for inspection of exhibits.

2 P.M.—Joint technical session American Electrochemical Society with American Institute Mining & Metallurgical Engineers at Chemical Exposition Auditorium.

2:30 P.M.—Meeting at Chemical Exposition of American Ceramic Society resumed.

3:30 P.M.—Meeting at Chemical Exposition of Technical Association of Pulp & Paper Industry resumed.

6:30 P.M.—Dinner of Technical Association of Pulp & Paper Industry at Union League Club.

8 P.M.—Motion pictures in Chemical Exposition Auditorium: 1. "Resistance Type Furnaces for Melting Non-Ferrous Metals." 2. "Electric Furnaces in Heat Treatment of Essential War Materials." (Both films by courtesy of Electric Furnace Co.) 3. "The Detroit Rocking Electric Furnace in Operation." (Courtesy of Detroit Electric Furnace Co.) 4. "Shawinigan Power Development and the Shawinigan Industries." (Courtesy of Shawinigan Water & Power Co.) 5. "The American Chemical Society Meeting, April, 1919, at the National Aniline & Chemical Co.'s plant, Buffalo, N. Y." (Courtesy Community Motion Picture Bureau.) 6. "The Making of Cut Glass." 7. "Manufacture of Glass."

THURSDAY, SEPT. 25

9:30 A.M.—Meeting at Chemical Exposition of Technical Association of Pulp and Paper Industry, general business meeting.

10 A.M.—Meeting of American Electrochemical Society jointly with American Institute of Mining & Metallurgical Engineers. Symposium on "Pyrometry" at Congress Hotel.

12 M.—Technical Association Pulp & Paper Industry adjournment for luncheon at and as guests of Sears Roebuck & Co., to be followed by visit to the paper mill plant.

2 P.M.—Meeting at Chemical Exposition Auditorium. "The Organization and Plans of the National Research Council With Special Reference to the Industries," H. E. Howe, National Research Council; "Fields for Industrial Development, Canadian National Railways," Price Green, Industrial Commissioner, Canadian National Railways; "Filtration," Henry B. Faber, Industrial Filtration Corp.; "Destructive Distillation of Bituminous Material with Reduced Vapor Tension and Complete Temperature Control," Thomas W. Pritchard, vice-pres. Fuel Products Corp.

4 P.M.—Committee meetings Technical Association Pulp & Paper Industry at Chemical Exposition.

8 P.M.—Motion pictures at Chemical Exposition, Jam Handy, vice-pres. Bray Studios, address during showing of first two films: 1. "Formation of Coal Made Visible." 2. "Chemistry of Gas Engines Made Visible."

8 P.M.—American Electrochemical Society smoker at Congress Hotel.

8:30 P.M. — Technical Association Pulp & Paper Industry smoker.

FRIDAY, SEPT. 26

Technical Association Pulp & Paper Industry will visit Forest Products Laboratory at Madison, Wis.

9:30 A.M.—Meeting American Electrochemical Society at Chemical Exposition Auditorium. Subject: Symposium on "Catalysis."

12:30 P.M.—Adjournment for luncheon.

2 P.M.—Meeting of American Electrochemical Society resumed.

8 P.M. — Motion pictures. Jam Handy, vice-president Bray Studios, address, "Art Exposes the Invisible in Chemistry," during the showing of special films: 1. "Chemistry in Munitions." 2. "Chemistry of Photography." 3. "Invisible Chemistry of the Electric Battery." 4. "Invisible Phases of Crystallation." "Natural Resources on C. N. Ry," Price Green, Industrial Commissioner of Canadian National Railways, address during showing stereoptican and motion pictures.

8 P.M.—Award of Willard Gibbs Medal to Prof. W. A. Noyes, University of Illinois, by Chicago Section of American Chemical Society.

SATURDAY, SEPT. 27

9:30 A.M.—Meeting at Chemical Exposition headquarters of Technical Association of Pulp & Paper Industry for adjourned business session in Auditorium.

Afternoon — Technical Association Pulp & Paper Industry official visits of inspection to exhibits at Chemical Exposition.

2 P.M.—Meeting at Chemical Exposition Auditorium. Symposium on Safety in Plant and Mine under chairmanship of M. F. Leopold, safety engineer, U. S. Bureau of Mines.

8 P.M.—Motion pictures, depicting safety work in the plant and mine, by courtesy of U. S. Bureau of Mines.

During the week at the Chemical Exposition there will be shown upon the motion picture program the following films not already placed by definite dates on this program: 1. "Operation of Koppers By-Product Coke Plant." (Courtesy The Koppers Co.) 2. "Continuous Motion Conveying, Stacking, Elevating, Loading and Unloading by Brown Portable Handling Machines." (Courtesy Brown Portable Conveying Machinery Co.) 3. "The Manufacture of Zinc Oxide." (Courtesy New Jersey Zinc Co.) 4. "The Making of Matches." 5. "Gold Mining in Canada." 6. "Building a Great Nitrate Industry at Muscle Shoals, Ala., by American Cyanamid Co." 7. "Quarrying Canadian Asbestos." 8. "Manufacturing Rubber Hose." 9. "Making Lime." 10. "The Silk Industry." 11. "The Steel Industry." 12. "The Iron Industry." 13. "The Oil Industry." 14. "Silver Mining in Bolivia."

American Electrochemical Society

MONDAY, SEPT. 22

6 P.M.—Registration begins at headquarters, Congress Hotel. Society headquarters at Exposition in booths 235-236 on balcony of Coliseum.

TUESDAY, SEPT. 23

All-day excursion by boat with the American Inst. of Mining and Metallurgical Engineers to Gary, Indiana, and trip through the United States Steel Co. plant. Details about tickets at the registration desk.

10 A.M.—Meeting of Directors.

12 M.—Luncheon at Steel plant.

1:30 P.M.—Inspection of United States Steel Co.'s plant.

Joint technical session with A. I. M. & M. E. General subject: "Iron and Steel."

8 P.M.—Joint technical session with the A. I. M. & M. E. at the Congress Hotel (continued).

WEDNESDAY, SEPT. 24

10 A.M.—Reading and discussion of papers at Chemical Exposition Auditorium.

"Manganin," M. A. Hunter and J. W. Bacon.

"The Activation of Carbon," N. K. Chaney.

"Depreciation in Small Dry Cells With Age," A. J. Helfrecht.

"The Effect of Amalgamation Upon the Single Potential of Aluminum," Louis Kahlenberg and John A. Montgomery.

"The Penetration of Iron by Hydrogen," T. S. Fuller.

"The Effect of Amalgamation Upon the Single Potential of the Binary Alloys of Al With Cu, Zn and Ni," Louis Kahlenberg and John A. Montgomery.

12:30 P.M.—Luncheon.

2 P.M.—Joint technical session with the A. I. M. & M. E. at Chemical Exposition Auditorium. General subject: "Ferrous and Non-ferrous Metallurgy."

"Radiant Resistor Furnace," F. A. J. FitzGerald.

"Electric Heat in the Typewriter Industry," A. M. Clark.

"Electric Furnace for Experimental Work," F. A. J. FitzGerald.

"A Square Deal for the Electric Furnace," H. G. Weidenthal.

(See also papers for this session on the program of the A. I. M. & M. E.)

Evening—Inspection of the electric furnace exhibits at the Exposition.

8 P.M.—Motion pictures in Exposition auditorium.

"Resistance Type Furnace for Melting Non-ferrous Metals."

"Electric Furnaces in the Heat Treatment of Essential War Materials." (Both by courtesy of Electric Furnace Co.)

"The Detroit Rocking Electric Melting Furnace in Operation." (Courtesy Detroit Electric Furnace Co.)

"Shawinigan Power Development and the Shawinigan Industries." (Courtesy Shawinigan Water & Power Co.)

THURSDAY, SEPT. 25

10 A.M.—Joint technical session with A. I. M. & M. E. Symposium on Pyrometry at Congress Hotel.

12:30 P.M.—Luncheon at the Congress Hotel.

2:30 P.M.—Continuation of joint session.

8 P.M.—Complimentary smoker at Congress Hotel, tickets of admission to be obtained from the registrar.

FRIDAY, SEPT. 26

9:30 A.M.—Reading of papers at the Chemical Exposition Auditorium.

12:30 P.M.—Luncheon.

Demonstration of the Manufacture of Fluorine (the Mathers process), F. C. Mathers.

"Commercial Possibilities in the Electrochemical Production of Organic Chemicals," C. J. Thatcher.

2:30 P.M.—Reading of papers continued at Exposition Auditorium.

"Lead Plating From Fluoborate Solutions," W. Blum, F. J. Liscomb, Zalia Jenks and W. E. Bailey.

"Factors Governing the Structure of Electrodeposited Metals," William Blum.

American Institute of Mining and Metallurgical Engineers

MONDAY, SEPT. 22

Morning — Registration begins at headquarters, Congress Hotel.

11 A.M.—Technical Sessions:

1. Session on Non-Ferrous Metallurgy and Metallography: Manufacture and Electrical Properties of Manganin, by F. E. Bash; Grain Growth in Alpha Brass, by F. G. Smith; Five Foundry Tests of Zinc Bronzes, by C. P. Karr; Manufacture and Electrical Properties of Constantan, by F. E. Bash; Tin Fusible Boiler Plug Manufacture and Testing, by L. J. Gurevich and J. S. Hromatke; Heat Treatment of Aluminum Alloy Castings, by Zay Jeffries and W. A. Gibson; Influence of Heat Treatment on Gun Metal, by C. F. Smart; The Deterioration of Nickel Spark-Plug Terminals in Service, by Henry S. Rawdon and A. I. Krynitzky; Heat Treatment of Duralumin, by Paul D. Merica, R. G. Waltenberg and H. Scott; Mechanical Properties and Resistance to Corrosion of Rolled Light Alloys of Aluminum and Magnesium, etc., by Paul D. Merica, R. G. Waltenberg and A. N. Finn; Simplification of Inverse-rate Method for Thermal Analysis, by Paul D. Merica; Constitution and Metallography of Aluminum and Its Light Alloys With Copper and With Magnesium, by Paul D. Merica, J. R. Freeman, Jr.; Some Properties and Applications of Rolled Zinc Strip and Drawn Zinc Rod, by C. H. Mathewson, C. S. Trewin and W. H. Finkelday; Physical Properties of Certain Lead-zinc Bronzes, by Homer F. Staley and C. P. Karr; Physical Properties of Nickel, by David H. Browne and John F. Thompson.

These papers will be read here by title only to afford opportunity for discussion when presented at the Philadelphia meeting of the Institute of Metals Division.

2. Session on Coal and Gas: Research in the Coal Mining Industry, by E. A. Holbrook; Factors Affecting the Washability of a Coal, by Thomas Fraser and H. F. Yancey; A Use Classification of Coal, by George H. Ashley; Distribution of Anthracite, by A. S. Learoyd.

2 P.M.—Technical Sessions: 1. Session on Coal and Gas: Height of the Gas Cap in the Safety Lamp, by C. M. Young; Engineering Features of Modern Large Coal Mines in Illinois and Indiana, by C. A. Herbert and C. M. Young; Gas-producer Practice, by G. S. Brooks and C. C. Nitchie; Testing of Coals for By-product Coking and Gas Manufacture, by Horace C. Porter; Coals of Ohio and Their Limitations for By-product Coke, by Wilber Stout; Outdoor Substations in Connection with Coal-mining Installations, by H. W. Young.

2. Session on Geology: Chrome-Ore Deposits in Cuba, by Ernest F. Burchard; Recent Studies of Domestic Chromite Deposits, by J. S. Diller; Manganese-ore Deposits in Cuba, by E. F. Burchard; Correlation of the Formations of the Huronian Group in Michigan, by R. C. Allen; Mud Volcanoes in Columbia, by Stanley C. Herold; Magnesite; Its Geology, Products and Their Uses, by C. D. Dolman; Titaniferous Iron Sands of New Zealand, by V. W. Aubel; Recent Studies of Domestic Manganese Deposits, by E. C. Harder and D. F. Hewett.

3. Session on Milling: Chilean-Mill Practice at the Portland Mill, by Luther W. Lennox; Graphic Metallurgical Control, by H. M. Merry; Mill Operations at the United Eastern During 1917-1918, by Wheeler O. North; Crushing Practice at New Cornelia Copper Co., by W. L. Du Moulin.

4. Session on Industrial Organization: Method of Curtailing Forces at the Copper Queen, by Charles F. Willis; Educational Methods at the Copper Queen, by Charles F. Willis; Physical Examination Previous to Employment, by Chas. F. Willis.

Evening—Smoker.

TUESDAY, SEPT. 23

Morning and Afternoon—Excursion by boat with the American Electrochemical Society to Gary, Indiana, and trip through the United States Steel Co. plant. During the afternoon upon the return trip, on the boat, technical session on Iron and Steel, jointly with American Electrochemical Society. Blast-Furnace Refractories, by Raymond M. Howe; Effervescing Steel, by Henry D. Hibbard; Aircraft Steels, by Albert Sauveur; Determining Gases in Steel and the Deoxidation of Steel, by J. R. Cain; Effect of Time and Low Temperature on Physical Properties of Medium-carbon Steel, by G. A. Reinhardt and H. L. Cutler; Erosion Tests of Rifle Barrels, by A. E. Bellis; Metallography of Rifle-barrel Steel, by G. F. Butterworth.

8 P.M.—Session on Iron and Steel, jointly with American Electrochemical Society (continued): Industries of the Chicago District, T. W. Robinson, Lantern Slides, etc.; Manufacture of Steel Rails, by Robert W. Hunt; 240-inch Plate Mill, by C. L. Huston.

8 P.M.—Session on Oil: Irvine Oil District, Kentucky, by Stuart St. Clair; Petroliferous Provinces, by E. G. Woodruff; Investigations Concerning Oil-Water Emulsion, by A. W. McCoy, H. R. Shidel and E. A. Trager; Essential Factors in the Valuation of Oil Properties, by Carl H. Beal; Application of

Law of Equal Expectations to Oil Production in California, by Carl H. Beal and E. D. Nolan; Value of American Oil Shales, by Charles Baskerville.

WEDNESDAY, SEPT. 24

10 A.M.—Technical Sessions:

1. Session on Iron and Steel: Cooling Properties of Technical Quenching Liquids, by N. B. Pilling and T. D. Lynch; Differential Crystallization in Cast-steel Runner, by Francis B. Foley; Manufacture and Properties of Light Wall Structural Tubing, by H. J. French; Oxygen in Cast Iron and Its Application, by Wilford L. Stork; Graphitization of White Cast Iron Upon Annealing, by Paul D. Merica and L. J. Gurevich; Experimental Data Obtained on Charpy Impact Machine, by F. C. Langenberg; Heat Treatment of Cast Steel, by John H. Hall, Arvid E. Nisson and Knox Taylor.

2. Mining and Local Resources: Wisconsin Zinc District, by W. F. Boericke and T. H. Garnet; Mineral Resources of the La Salle District, by J. A. Ede; New Angles to the Apex Law, by John A. Shelton; Mining Methods of Alaska Gastineau Mining Co., by G. T. Jackson; Tunnel Driving at Copper Mountain, B. C. (Columbia Section Paper), by Oscar Lachmund; Geology and Mining Methods at Pilares Mine, by Alfred Wandtke, W. Rogers Wade; Wedging Diamond-drill Holes, by O. Hall and V. P. Row.

3. Session on Sulphur in Coal: Geographic Distribution of Sulphur in the West Virginia Coal Beds, by I. C. White; Occurrence and Origin of Finely Desseminated Sulphur Compounds in Coal, by Rheinhardt Thiessen; Mechanical Separation of Sulphur Minerals From Coal, by J. R. Campbell; Sulphur in Coal—Geological Aspects, by George H. Ashley; Forms in Which Sulphur Occurs in Coal, by A. R. Powell; Effect of Sulphur in Coal Used in Ceramic Industries, by C. W. Parmelee.

2 P.M.—Technical Sessions:

1. Session on Non-Ferrous Metallurgy, jointly with American Electrochemical Society at Chemical Exposition Auditorium: Electric-Resistance Furnace of Large Capacity for Zinc Ores, by Charles H. Fulton; Water and Chlorides in Cement Copper, by Edward Keller; Chemical and Electrochemical Problems Involved in the New Cornelia Copper Co.'s Leaching Process, by Henry S. MacKay; Electrolytic Zinc, by C. A. Hansen; Treating Antimony Ores, by George P. Hulst.

2. Session on Sulphur in Coal: Removal of Sulphur From Illuminating Gas, by W. W. Odell and W. A. Dunkley; Low Sulphur in Coal, by H. M. and T. M. Chance; Low-Sulphur Coals of Kentucky, by Willard R. Jillson; Low-Sulphur Coal in Illinois, by Gilbert H. Cady; Sulphur in the Coking Process, by S. W. Parr; Commercial Recovery of Pyrite from Coal, by S. H. Davis; Sulphur in Producer Gas, by Frederick Crabtree and A. R. Powell.

3. Session on Pyrometry With Special Reference to Iron and Steel Metallurgy: Report of the Pyrometer Committee of National Research Council, by George K. Burgess; Pyrometry in Blast-Furnace Work, by P. H. Royster and T. L. Joseph; Pyrometer and Steel Manufacture, by A. H. Miller; Electric Open Hearth and Bessemer Steel Temperatures, by F. E. Bash; Some Thermal Relations in the Treatment of Steel, by Chas. F. Brush; Pyrometry in the Tool Manufacturing Industry, by J. V. Emmons; Forging Temperatures and Rate of Heating and Cooling of Large Ingots, by F. E. Bash.

Evening — Banquet at Congress Hotel.

THURSDAY, SEPT. 25

10 A.M.—Optional excursion to De Pue, Ill., by train for inspection of zinc smelters, cement works and coal mines. Trip to Starved Rock and points of historical interest.

10 A.M. and 2 P.M.—Technical meeting, subject: Symposium on Pyrometry, jointly with American Electrochemical Society: Temperature, by J. S. Ames; Standard Scale of Temperature, by C. W. Waidner, E. F. Mueller and Paul D. Foote; Metals for Pyrometer Standardization, by C. W. Waidner and George K. Burgess; Fundamentals of Pyrometry, by C. E. Mendenhall; Thermoelectric Pyrometry, by Paul D. Foote, T. R. Harrison and C. O. Fairchild; Potentiometers for Thermoelement Work, by Walter P. White; Self-Checking Galvanometer Pyrometer, by H. F. Porter; Some Factors Affecting the Use of Base-Metal Thermocouples, by O. L. Kowalke; Curves and Tables to Represent the Relation Between Thermal E.M.F. and Temperature, by L. H. Adams; Reference Standard for Base-Metal Thermocouples, by N. E. Bonn; Alloys Suitable for Thermocouples and Base-Metal Thermoelectric Practice, by J. M. Lohr; Recent Improvements in Pyrometry, by R. P. Brown; Automatic Correction for Temperature of Cold Junctions, by F. Wunsch; A Hot Wire Anenometer with Thermocouple, by T. S. Taylor; Porcelain for Pyrometric Purposes, by F. H. Riddle; Pyrometer Porcelain and Refractories, by R. W. Newcomb; Porcelain Pyrometer Protecting Tubes, by F. A. Harvey; Porcelain Tubes for Thermocouples, by R. B. Lincoln; Melting Point for Refractory Materials, by Leo I. Dana; High Temperature Scale and Its Application in the Measurement of True, Brightness and Color Temperature, by Edward P. Hyde; Theory and Accuracy in Optical Pyrometry, by W. E. Forsythe; Optical and Radiation Pyrometry, by Paul D. Foote and C. O. Fairchild; Industrial Application of the Disappearing-Filament Type of Optical Pyrometers, by F. E. Bash; Use of the Optical Pyrometer for Control of Optical-Glass Furnaces, by C. N. Fenner; Emissive Powers and Temperatures of Non-Black Bodies, by A. G. Worthing; Recording Thermocouple Pyrometers, by Lee Behr; Recording Pyrometry, by C. O. Fairchild and Paul D. Foote; A Remote Control Valve Operating Mechanism for Hand or Automatic Control, by R. W. Newcomb and C. Engelhard; High Temperature Control, by C. O. Fairchild and Paul D. Foote; Resistance Thermometry, by F. W. Robinson; Tin, an Ideal Pyrometric Material, by E. F. Northrup; Resistance Thermometry for Industrial Use, by Charles P. Frey; Temperature Measurement in Optical Glass Annealing Furnaces, by E. D. Williamson and H. S. Roberts; Annealing of Glass, by A. Q. Tool and J. Valasek; Pyrometry Applied to Bottle-Glass Manufacture, by R. L. Frink; Pyrometry in the Manufacture of Optical Glass, by Albert J. Wolcott; Pyrometry as Applied to the Manufacture of Optical Glass, by Carl W. Keuffel; Pyrometer Shortcomings in Glass-House Practice, by W. M. Clark and Charles D. Spencer; Temperature in the Manufacture of Pottery, by F. K. Pence; Pyrometry in the Chemical Industry as Applied to Gas Mask Manufacture, by K. Marsh; Application of Pyrometry to the Ceramic Industries, by C. B. Thwing; Pyrometry in Rotary Portland Cement Kilns, by Leo I. Dana and C. O. Fairchild; Application of Pyrometers to Ceramic Industry, by John P. Goheen; Temperatures of Incandescent Lamp Filaments, by Benjamin E. Shackleford; Temperature Measurements of Incandescent Gas Mantles, by H. E. Ives; Application of Pyrometry to Problems of Lamp Desire and Performance, by I. H. Van Horn; Use of Modified Rosenhain Furnace for Thermal Analysis, by H. Scott and J. R. Freeman; High Temperature Thermometers, by R. M. Wilhelm; Temperature of a Burning Cigar, by T. S. Sligh and C. S. Kraybill; Teaching Pyrometry in Our Technical Schools, by George V. Wendell; Teaching Pyrometry, by C. E. Mendenhall; Teaching Pyrometry, by O. L. Kowalke; Present Status of Radiation Constants, by W. W. Coblentz; Pyrometer Protection Tubes, by Otis Hutchins.

FRIDAY, SEPT. 26

Continuation of adjourned Technical Sessions:

Morning—Optional Trips. 1. North Chicago and Milwaukee. 2. East Chicago metallurgical plants and oil refineries at Whiting, Indiana. 3. Local Chicago plants. 4. Coal trip to Franklin and Macoupin counties.

Technical Association of the Pulp and Paper Industry

The following tentative program of meetings, excursions and entertainments of the Technical Association of the Pulp and Paper Industry, Chicago, has been prepared. More extensive details will appear in the final program.

Sept. 24, 25, 26 and 27—All meetings are to be held in conjunction with the Fifth National Exposition of Chemical Industries in the officers' Board Room of the First Regiment Armory, Sixteenth St. and Michigan Boulevard, and at the Coliseum, Wabash Av. and Fifteenth St., Chicago. Admission by T. A. P. P. I. badge. Members are requested to register at T. A. P. P. I. booth, No. 237, and at the entrance to the Armory, immediately on arrival any time during the week.

WEDNESDAY, SEPT. 24

10 A.M.—Opening meeting in First Regiment Armory. Address of welcome. Opening remarks by the president. Report of the executive committee. Report of the secretary-treasurer, followed by reports of standing committees: Abstracts of Literature,

Ross Campbell, chairman; Bibliography, Henry E. Surface, chairman; Heat, Light and Power, Edward P. Gleason, chairman; Paper Testing, Frederick O. Clark, chairman; Soda Pulp, Martin L. Griffin, chairman; Standard Methods of Testing Materials Used in the Manufacturing of Paper, William H. Gesell, chairman; Sulphate Pulp, Olai Bache-Wiig, chairman; Sulphite Pulp, Herbert C. Spear, chairman; Vocational Education, George E. Williamson, chairman.

Among the special papers and reports to be presented and discussed is one entitled "The Principles and Practice Involved in Washing Unbleached Soda Pulp." This will form the report of the committee on Soda Pulp, Martin L. Griffin, chairman.

The committee on Sulphate Pulp, O. Bache-Wiig, chairman, will make a report on tests which have been made to determine the loss of soda in the evaporation of black liquor in sulphate mills. The report is not expected to be a lengthy one, but it will be characterized by great accuracy, the tests having been made by the same chemists in a number of different pulp mills. Methods of overcoming avoidable waste will be described in the report.

The committee on Paper Testing, Frederick C. Clark, chairman, promises a revised report on methods of testing paper which should prove of great interest and value.

12:30 P.M.—Intermission for luncheon and tour of Exposition.

3:30 P.M.—Adjourned session in First Regiment Armory.

An account of research work on the important problem of waste sulphite liquor utilization will be presented by Prof. Ralph H. McKee and George Barsky, of Columbia University, in a paper entitled "Fuel From Waste Sulphite Liquor."

6:30 P.M.—Dinner at the Union League Club.

THURSDAY, SEPT. 25

9:30 A.M.—Assemble at T. A. P. P. I. Registration Booth, No. 237, in Coliseum for business meeting.

1 P.M.—Adjournment for visit to paper mill plant of Sears, Roebuck & Co.; luncheon as guests of the firm.

2 P.M.—Inspection tour of the Sears, Roebuck & Co. plant.

4 P.M.—Committee meetings and special papers.

8:30 P.M.—Smoker and entertainment.

FRIDAY, SEPT. 26

The day will be spent in a visit of inspection to the Forest Products Laboratory of the Forest Service, U. S. Department of Agriculture, Madison, Wis. Train arrangements provide for members taking a late train from Chicago on Thursday evening and arriving in Madison early Friday morning, or leaving late in the afternoon so as to reach Madison shortly after 9 o'clock in the evening. Hotel accommodations at Park Hotel. Sleeping car in the train leaving Chicago at 2 A.M. on Sept. 26 is ready for occupancy the previous evening at 10 o'clock; the train is due to arrive in Madison at 7:20 A.M. Friday. The departure from Madison will be made on Friday at 5:40 P.M., arriving in Chicago at 10:30 P.M. The first class fare from Chicago to Madison is $4.21, and sleeper berth $1.60. Notice of intention to take the trip should be sent promptly to Chairman Savery.

SATURDAY, SEPT. 27

9:30 A.M.—Adjourned business sessions at the National Exposition of Chemical Industries.

American Steel Treaters Society

TUESDAY, SEPT. 23

9 A.M.—Registration Seventh Regiment Armory.

10 A.M.—Address of welcome: Hon. Harry H. Merrick, president Chicago Association of Commerce.

Address of welcome: Acting President T. E. Barker.

Report of Acting Board of Directors by Acting Secretary A. G. Henry.

Report of Finance Committee: Acting Chairman A. F. Boissoneau.

Paper: Relation of Heat Treatment, Design and Selection of Steels for Metal Cutting Tools to Factory Production: C. P. Berg, President, C. P. Berg & Co., consulting engineers.

Visit to Exhibits.

Afternoon Session—2-4:30—Presiding Officer, Horace H. Clark, chairman Chicago Chapter.

2 P.M.—Report of tellers of election. Address of president-elect.

Papers: Heat Treatment of Steels for Cutting Purposes.

8-10 P.M.—Presiding officer, G. Walter Esau, chairman Milwaukee Chapter.

8 P.M.—Papers: Case Hardening in General.

WEDNESDAY, SEPT. 24

Morning Session—10-12 — Presiding officer, David Bell, chairman Buffalo Chapter.

10 A.M.—Papers: Heat Treatment of Miscellaneous Products.

Afternoon Session—2-4 — Presiding officer, B. F. Weston, chairman Pittsburgh Chapter.

2 P.M.—Papers: Heat Treatment of Steel for Intermittent Cutting Purposes.

Evening Session — 8-10 — Presiding officer, George W. Pressell, chairman Philadelphia Chapter.

8 P.M.—Papers: Results of Investigation Pertaining to Heat Treatment.

THURSDAY, SEPT. 25

Morning Session—10-12 — Presiding officer, W. S. Bidle, chairman Cleveland Chapter.

10 A.M.—Papers: Heat Treating Equipment.

Afternoon Session—2-4:30 — Presiding officer, Frank P. Fahy, chairman New York Chapter.

2 P.M.—Papers: Solution of Modern Demands on Heat Treating.

6:30 P.M. Sharp.—Informal banquet and entertainment, Cameo Room, Morrison Hotel. Tickets $3.

FRIDAY, SEPT. 26

10 A.M.—Exhibit at Seventh Regiment Armory. Plant visitation.

7 P.M.-10 P.M.—Band concert. Third Regiment Military Band.

SATURDAY, SEPT. 27

"Chicago Day."

Exhibition open 10 A.M.-10 P.M.

2 P.M. and 7 P.M.—Band Concert—Third Regiment Military Band.

THE PAPERS

No one knows all about the Heat Treatment of Steel, and no one makes any claim. Investigations and progress are being made every day, and one should keep up with the advance progress in this phase of manufacture.

A partial list of papers in preparation is given below. They cover the very latest advancement in every field of the heat treating art, and are prepared by experts.

"Modern Pyrometry," A. W. Anderson, C. S. Gordon Company.

"Metallography of Steel," Cyril J. Atkinson, Laboratories, Milwaukee, Wis.

"Annealing Large Sections of Cast Nickel Steel," G. A. Brewster, American Steel Foundries, Chicago, Ill.

"Salts for Quenching," Shipley N. Brayshaw, London, England.

"Relation of Heat Treatment, Design and Selection of Steels for Metal Cutting Tools to Factory Production," C. P. Berg, C. P. Berg & Co., Chicago, Ill.

"Results of Investigations Pertaining to Heat Treating," Ray T. Bayless, James H. Herron Company, Cleveland, Ohio.

"Pyrometry," R. P. Brown, President, Brown Instrument Company, Philadelphia, Pa.

"Cast Steel," Alvin N. Conarroe, chemist and metallurgist, National Malleable Castings Company.

"Electric Heating of Steel," E. F. Collins, General Electric Company.

"Case Hardening in General," Wm. G. Conner, Geo. D. Whitcomb Manufacturing Company, Rochelle, Ill.

"Heat Treatment of Balls for Bearings," Arthur L. Collins, Atlas Ball Company, Philadelphia.

"Effects of Forging Temperatures on Heat Treatment of Steels," D. R. Cornell, Standard Forgings Company, Indiana Harbor, Ind.

"Heat Treatment of Cast Steel," Wm. Geo. Dauncey, Associate Editor, *Iron and Steel*, Montreal, Canada.

(1) "The Function of Oil Burners in the Operation of Furnaces," (2) "Factors to be Considered in the Heating and Cooling of Steel," Jas. A. Doyle, New York City.

"Steels for Projectiles," C. W. Diemecke, Miehle Printing Press and Manufacturing Company, Chicago, Ill.

"Case Hardening in General," Chas. Eiser, Service Station Equipment Company, Chicago, Ill.

"A New Compensated Heatmeter," Charles P. Frey, Philadelphia, Pa.

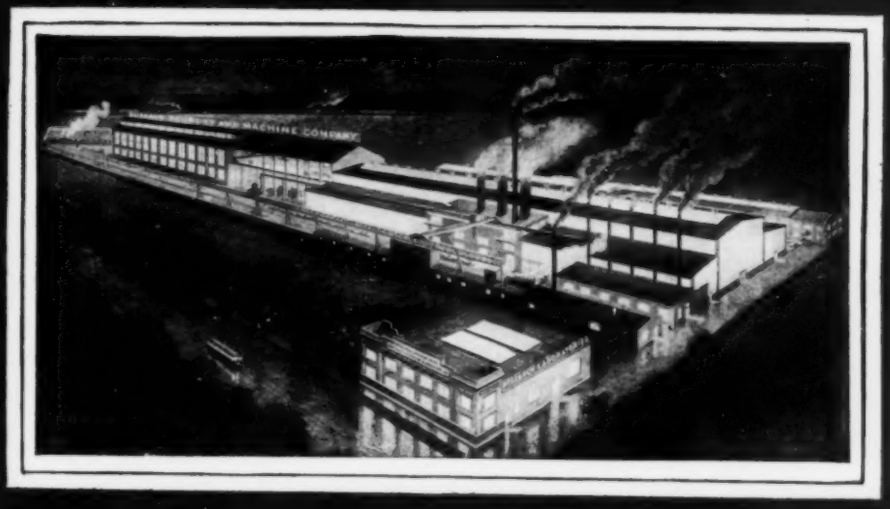
"Steel for Electrical Purposes," Frank P. Fahy, New York City.

"Results of Investigations Pertaining to Heat Treating," Frederick J. Griffiths, Central Steel Company, Massillon, Ohio.

"Heat Treatment of Rifle and Machine Gun Barrels," Arthur W. F. Green, John Illingsworth Steel Company, Philadelphia, Pa.

"Heat Treatment of Cast Steel in Tractor Construction," Fred Grotts, Holt Manufacturing Company, Peoria, Ill.

Chemical Equipment and Vacuum Apparatus



Buffalo Foundry & Machine Co.
Buffalo, N.Y.

Chemical Equipment and Vacuum Apparatus

Vacuum Drying Apparatus
Evaporators
Chemical Apparatus
Sugar Plants - Sugar Refineries
Extract Plants
Caustic Plants

Buffalo Foundry & Machine Company
1543 Fillmore Avenue, Buffalo, N. Y.
New York Office: 17 Battery Place

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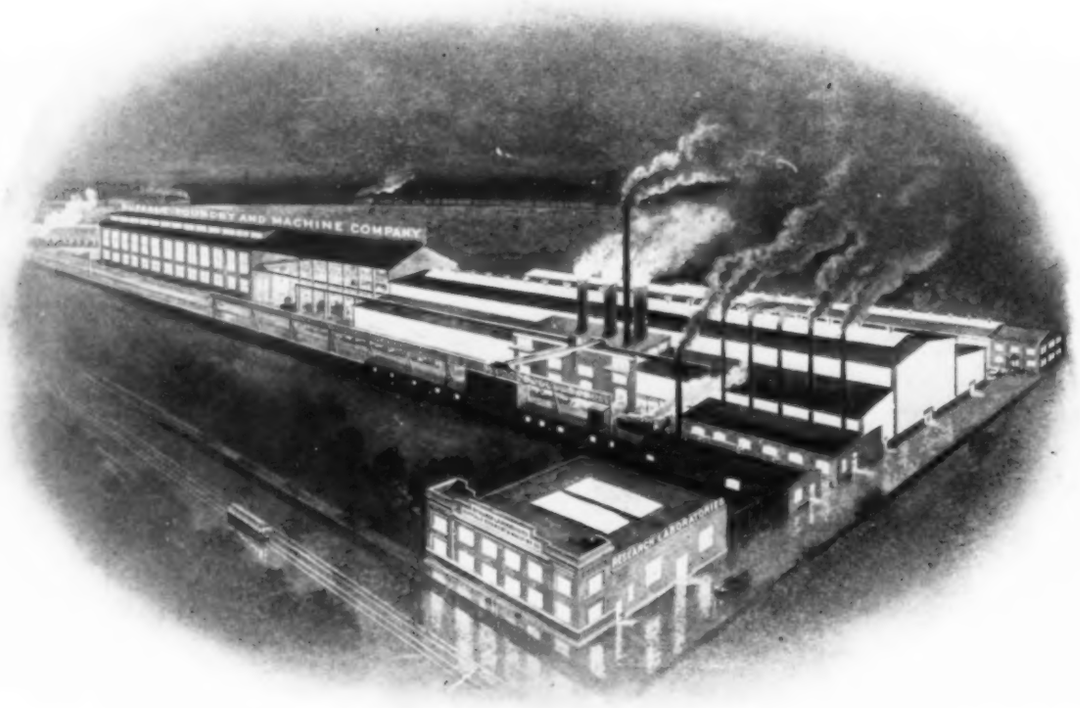
BUFFALO FOUNDRY AND MACHINE COMPANY



"THE PLANT BEHIND THE APPARATUS"

2

Foreword

THIS catalog has been prepared to give the reader a general idea of our engineering and manufacturing facilities, research laboratories, consulting specialties, etc. The equipment described includes chemical apparatus, vacuum dryers and evaporators of our standard construction. However, we build other lines of equipment, including complete extract plants, causticizing equipment, waste product machinery, sugar plants and complete sugar refineries. We also build special apparatus to order for other requirements.

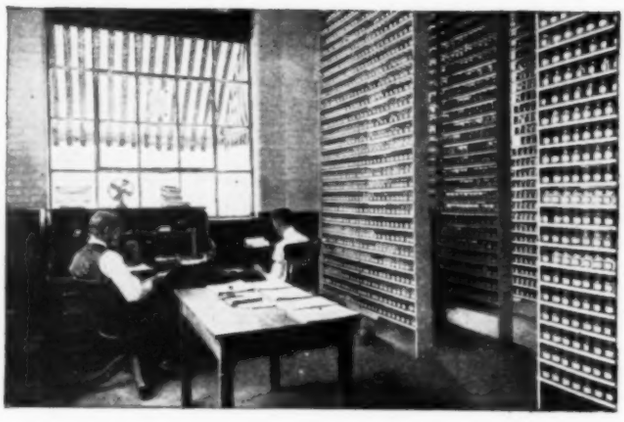
Simplicity in construction, efficiency in operation and durability in service are some of the distinguishing features of "Buflokast" and "Buflovak" Apparatus. In other words, they are

"Built for Tomorrow's Satisfaction
Instead of Today's Price"

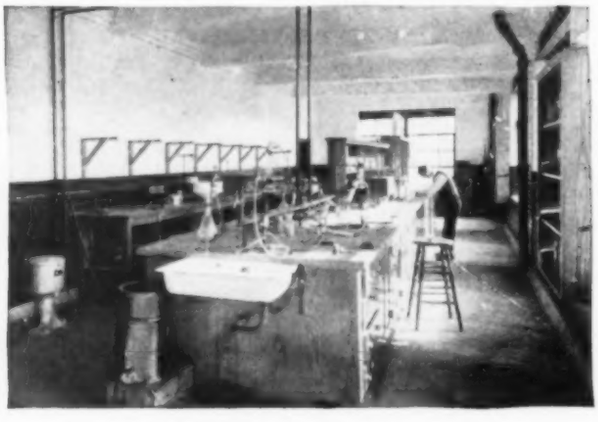
A Trip Through the Plant

Research Laboratories

The Research Laboratories are composed of two main sections, Analytical and Mechanical. The first comprises the various chemical laboratories, which are maintained for conducting the analytical work connected with our research department. The second consists of the mechanical testing laboratories containing working units of various apparatus, where practical tests are made on customer's materials to determine the apparatus best adapted to their products.



Vacuum Drying Laboratory



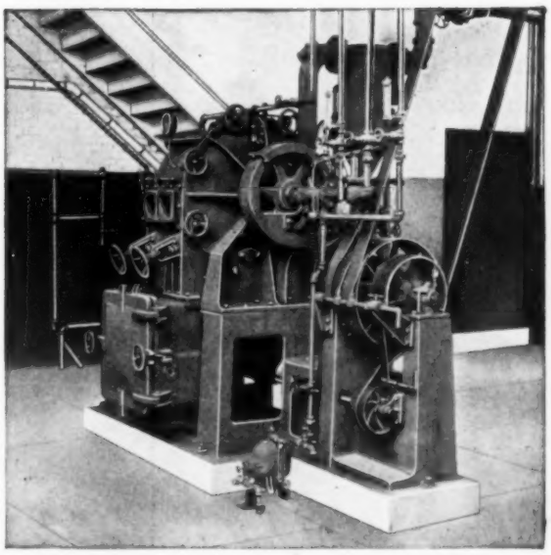
Organic Chemical Laboratory

These laboratories are in charge of chemists, metallurgists and experts who are thoroughly experienced in the chemical processes and mechanical operations involved in the use of our apparatus.

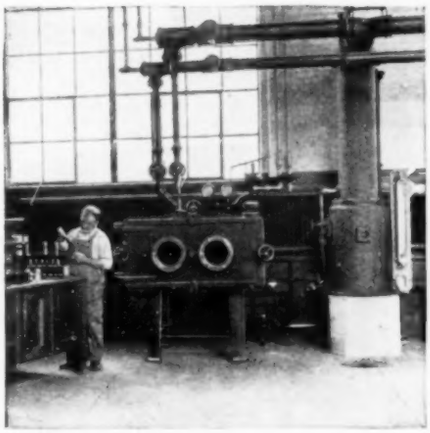
A Trip Through the Plant—*Continued*

Testing Laboratories

This section contains working units of various chemical apparatus and each standard type of evaporator and vacuum dryer we build, thus making it possible to conduct experiments on any material in each type of apparatus to determine the one best adapted to handle the same.

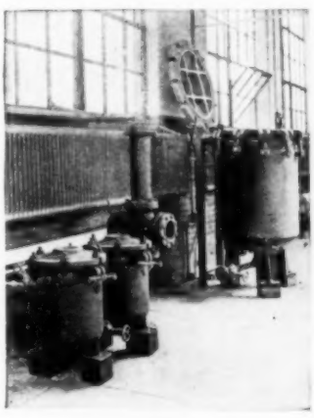


Vacuum Drum Dryer in Testing Laboratory

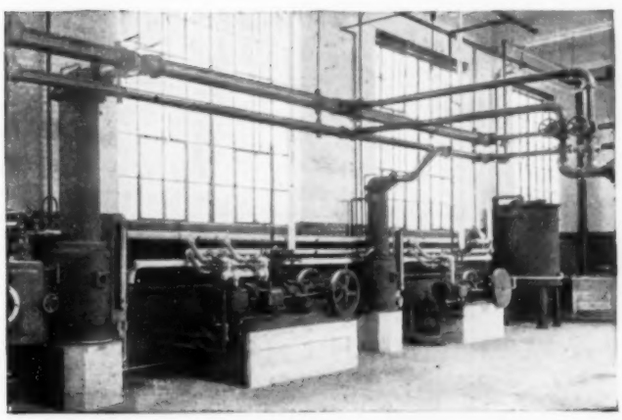


Vacuum Shelf Dryer and Surface Condenser

In the lower illustration are shown two of the vacuum pumps used in these laboratories. The arrangement of the piping on these pumps is such that either pump can be connected to any piece of vacuum apparatus in the testing room, thus permitting the operation of any apparatus with a single or two-stage pump as desired.

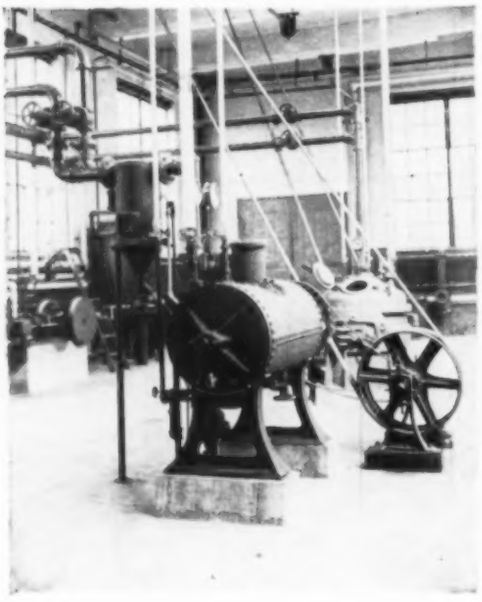


Impregnating Apparatus in Testing Laboratory

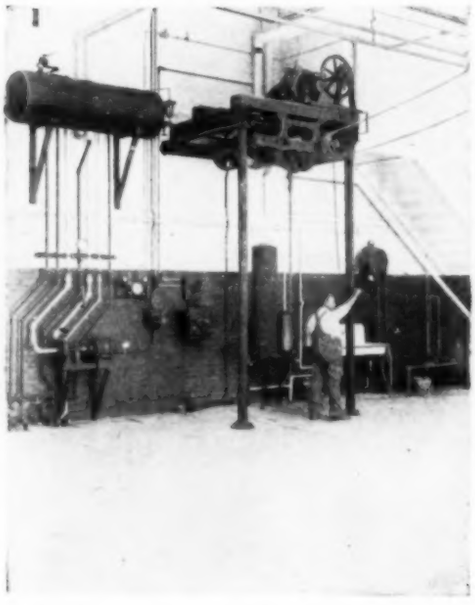


Vacuum Pumps, Surface Condensers and Expansion Tank

A Trip Through the Plant—*Continued*



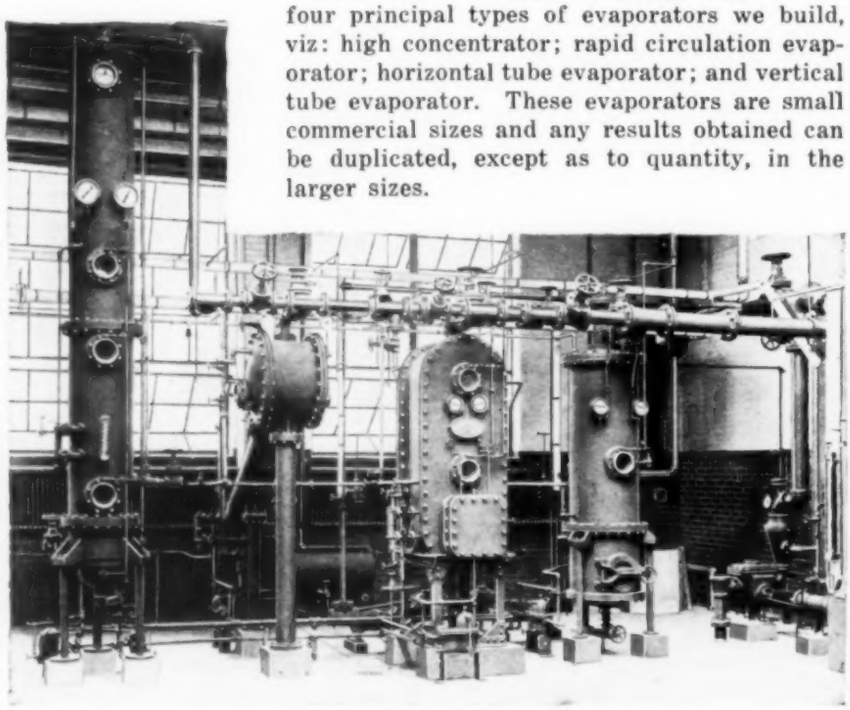
View in Testing Laboratory showing Vacuum Rotary Dryer, Vacuum Crystallizer, etc.



Speed Changing Device. Used for obtaining any speed required for operating any apparatus in Testing Laboratory

Laboratory Evaporators

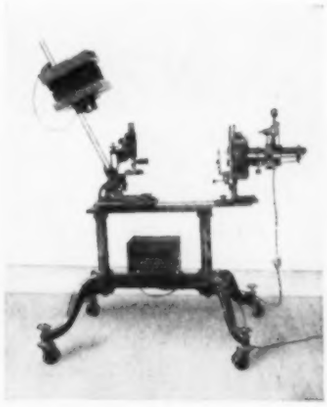
This section contains working units of the four principal types of evaporators we build, viz: high concentrator; rapid circulation evaporator; horizontal tube evaporator; and vertical tube evaporator. These evaporators are small commercial sizes and any results obtained can be duplicated, except as to quantity, in the larger sizes.



Partial View of Evaporator Section in Research Laboratories

A Trip Through the Plant—*Continued*

A Corner in the Metallurgical Laboratory



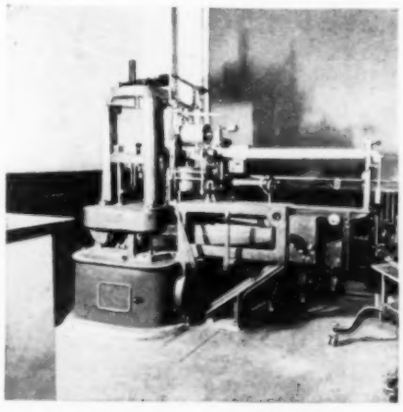
Micro-Photographic Camera in Metallurgical Laboratory

Metallurgical Laboratories

Here are determined the most suitable metal mixtures and other data for the production of castings used in our various lines of work. Besides analyzing such materials as pig iron, coke, etc., finished products are carefully checked chemically and physically and given a microscopic examination in the Micro-Photographic Laboratory.

Electro-Metallurgical Development Department

Recognizing the possibilities of electro-metallurgy as applied to the production of castings, a separate department is maintained for electro-metallurgical experiments in the development of the special metals used in our various lines as well as those metals required for other special purposes.



Physical Testing Apparatus in Metallurgical Laboratory

Metallurgical Laboratory — Cupola or Melting Furnace used for making laboratory metal mixtures

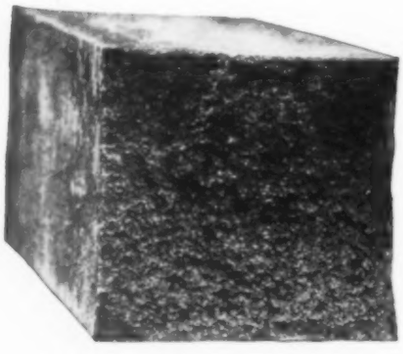
A Trip Through the Plant—*Continued*

Laboratory Control

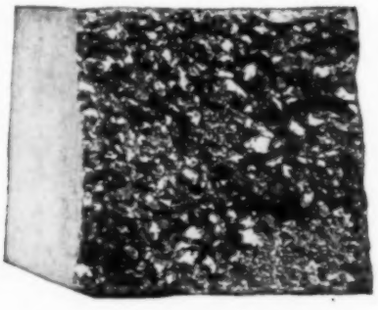
Laboratory control, which was first applied successfully to the manufacture of castings on a chemical basis, is the dominating idea behind every product of this company.

The illustrations show some of the results of laboratory-control as applied to the question of metal alone.

Metallurgical Laboratory—Office of Chief Chemist



Close Grain Cast Iron Section



Open Grain Cast Iron Section

Cast Iron Spring—Open

On the one hand is shown a section of cast-iron of an extremely dense, homogeneous quality—on the other, a porus, open-grained iron. The other illustrations (the springs) indicate a mixture of iron having unusual ductile qualities. A spring was cut from a solid piece of cast iron, making a spring 19 in. long in its normal position, as shown by the first illustration. The other cut shows it compressed to 2 in.

The spring can be pulled out, without breaking, to more than double its length.

Cast Iron Spring—Closed

A Trip Through the Plant—*Continued*

LABORATORY CONTROL—*continued*

The bars shown above demonstrate still another quality. These were cast square and straight, after which they were twisted as shown in the cuts, a test which had always been considered impossible on cast iron.

These widely differing qualities of metal, with many grades and variations of the same, are made possible by the system of exact control established over our various manufacturing processes.

Other factors are treated with the same care, no detail looking toward the efficiency and durability of "Buflokast" and "Buflovak" products being too small to receive the most careful attention.

The Full Significance of "Buflokast" and "Buflovak"

Besides being distinguishing marks by which certain products may be identified, these names have another and deeper significance. Either name when appearing upon or applied to the products of this company means that it is the best that can be built regardless of price. It becomes a stamp of quality—standing for certain fixed principles in manufacture and a definite standard of service.

They represent the application to each customer's particular problem, of predetermined facts, based on scientific research and manufacturing experience. In short, "Buflokast" and "Buflovak" are names by which may be recognized the most satisfactory and most economical vacuum drying apparatus, evaporators, sugar mill machinery and chemical equipment. They stand for, not the lowest initial cost, but the lowest ultimate cost—the only true standard of economy. Quality and not price is the basis on which these products are built and sold.

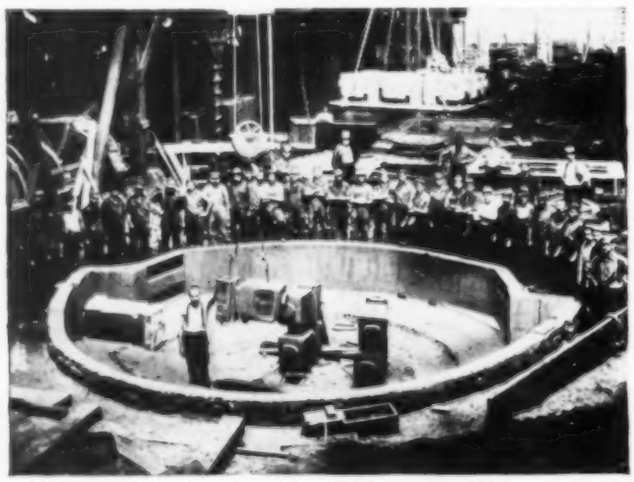
A Trip Through the Plant—*Continued*

The Foundry

This cut shows a section of the foundry containing the melting equipment consisting of three cupolas and an air furnace. The cupolas are respectively 102, 84 and 66 inches in diameter and have a total melting capacity of 55 tons per hour.

Air Furnace

Used for producing "Buflokast" Acid-Resistant and other special metals in the manufacture of our various lines. In practice it is operated like a large crucible so that practically any quality of iron desired can be produced in this furnace with almost laboratory exactness.

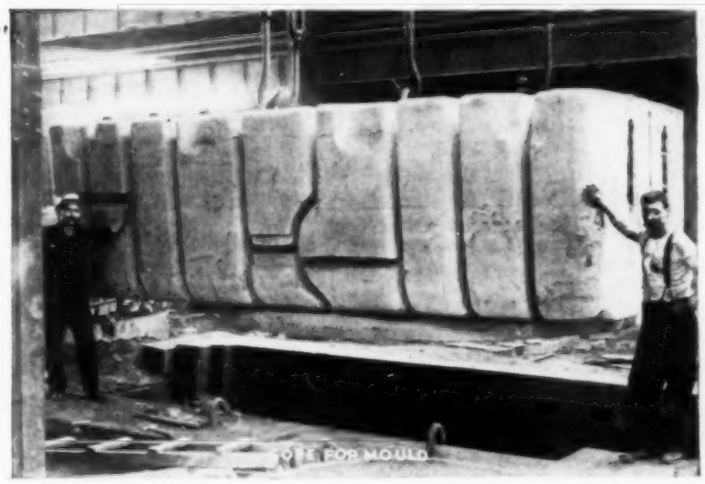


Mold for Casting shown on the right

Casting made in mold shown on the left

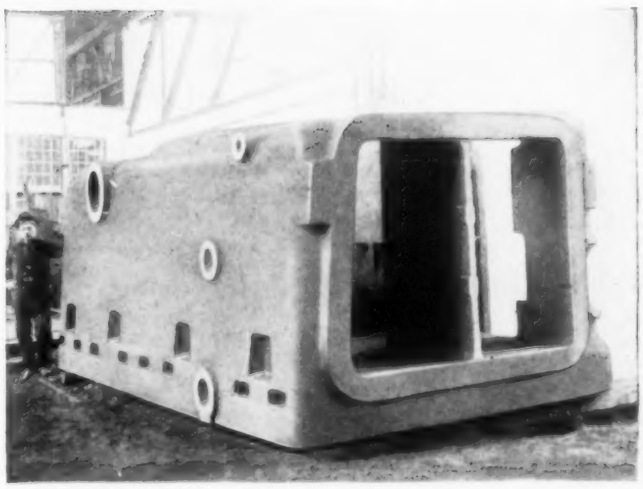
A Trip Through the Plant—*Continued*

Our facilities enable us to make castings weighing up to 200 tons each. Frequently the cores weigh almost as much as the casting itself, so that it is necessary to have exceptional crane capacity to lift the castings from the mold after being cast.



Core being placed in the mold shown above. We are well equipped with core-drying facilities, having 32,000 cubic feet of core-oven capacity, and can dry a single mold or core up to 25 feet long, 25 feet wide and 14 feet high.

Turbine condenser base casting: Mold and core are both shown above. Weight, 74,000 lb.

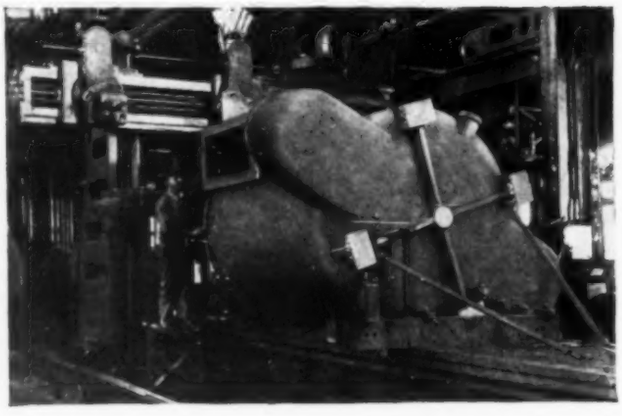


BUFFALO FOUNDRY AND MACHINE COMPANY

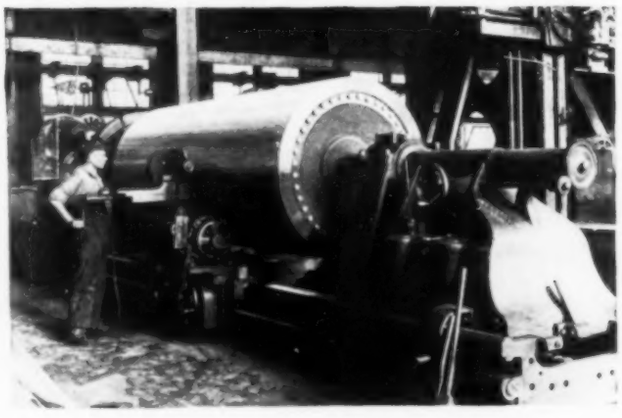
A Trip Through the Plant—*Continued*

Machine Shops

These are equipped with the largest and most up-to-date appliances for turning out work accurately and with despatch. The cuts illustrate the size and flexibility of some of our equipment.



Machining Hough Type Nitrator Body on Planer

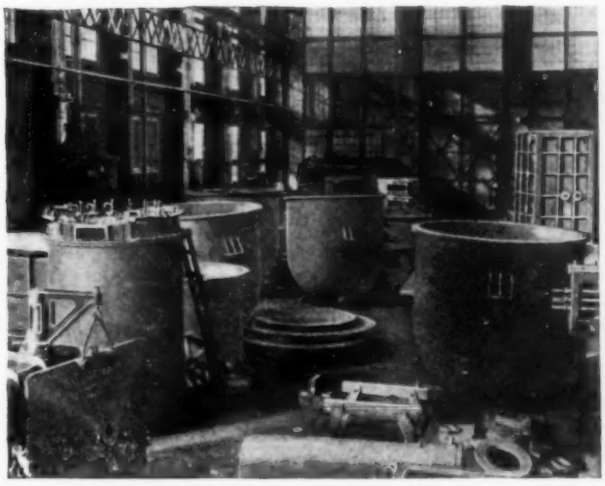


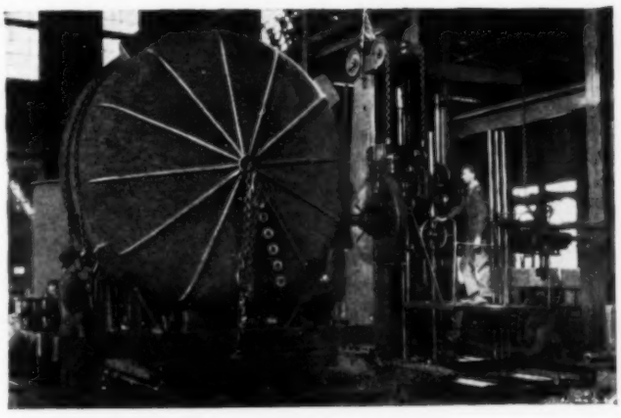
Machining a drum for a vacuum drum dryer. The face of the drum is being ground after being turned. These drums are made of a special quality of metal, high in tensile strength and capable of taking a high polish.

A Trip Through the Plant—*Continued*

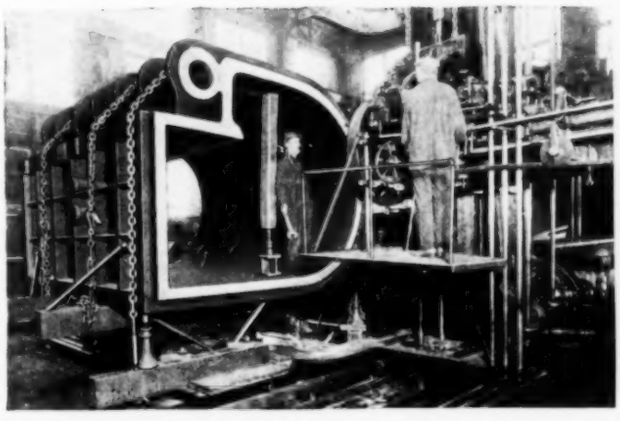
Machine Shops

Another view of the main machine shop. An interesting feature about our plant is the fact that it is operated by power derived from Niagara Falls. The current is received at 2200 volts and reduced in our power house to 220 volts.





Casting for special evaporator being machined on horizontal floor boring machine



Machining a cast-iron casing for a vacuum drum dryer. These casings are cast on end with a large riser, thereby insuring that degree of density and soundness required in high vacuum apparatus.

A Trip Through the Plant—*Continued*

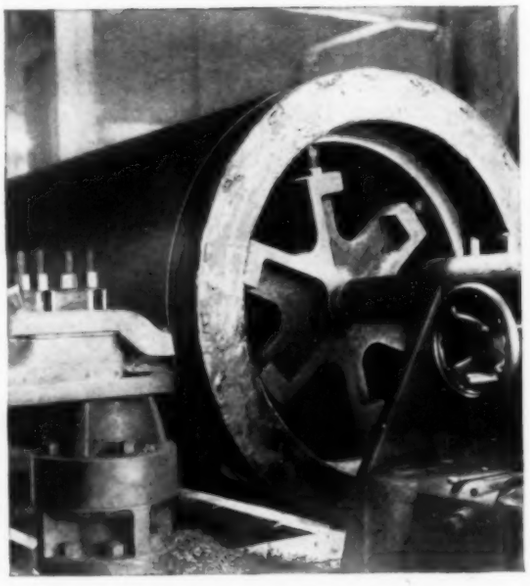
Pouring Casting or end in Foundry.

Pouring Castings on End

Pouring castings on end is one of the methods used for obtaining castings of sufficiently high quality for our apparatus. The pressure in the mold due to the high head of liquid metal produces a very dense close-grained iron. Special methods of gating and pouring cause impurities to come to the top in the riser which is later removed.

Risers

These cuts illustrate the practice of making castings with large risers, which insure clean, sound, dense castings, free from blow holes, impurities, etc. This illustration shows a riser being removed from a drum casting. Note the height and width of the riser on one of the kettles shown on the opposite page. The riser has been removed from the kettle being machined.



Cutting riser off Drum Casting.

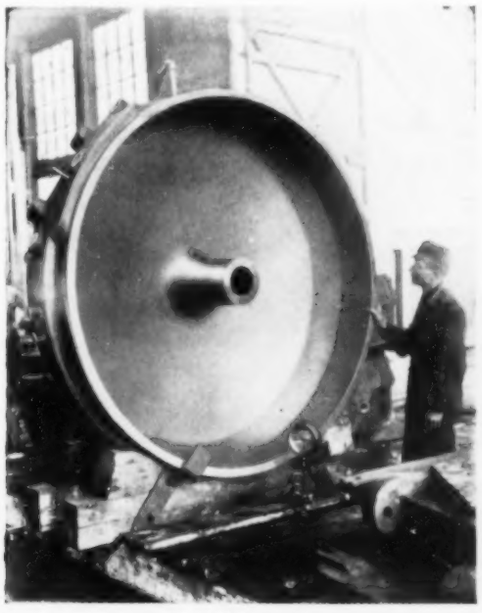
A Trip Through the Plant—*Continued*

Fusion Kettles, before and after removing riser. (*See page* 14)

Testing

Every piece of "Buflokast" and "Buflovak" apparatus is assembled and carefully tested before shipment is made. In fact the test is far more severe than is encountered in actual operation. In this way customers are assured of receiving equipment of the highest standard throughout and ready to operate when installed.

Tubes for High Concentrator being tested under pressure



Testing Steam Jacket of Crystallizer under pressure

A Trip Through the Plant—*Continued*

Pattern Shop

Our pattern making department is modern and up to date, and is a model for producing patterns at a minimum cost. New patterns and alterations are made in a manner most suitable for economical and accurate molding.

Pattern Storage

Special attention has been given to the storage of patterns. All patterns received from customers are carefully checked to drawing before going to the foundry. They are as well taken care of by us as they could be by the owner.

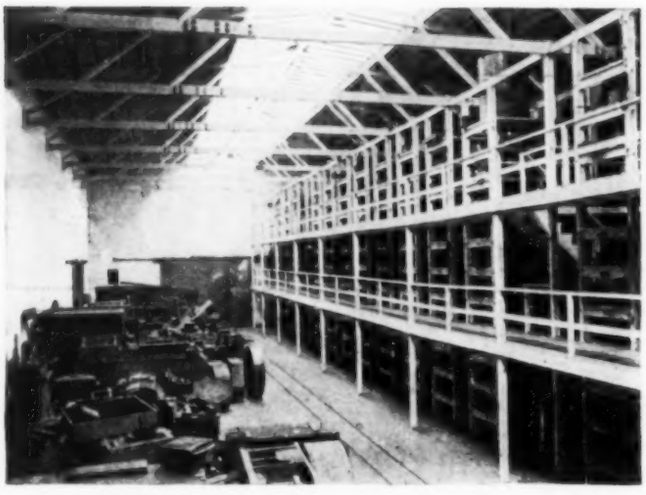


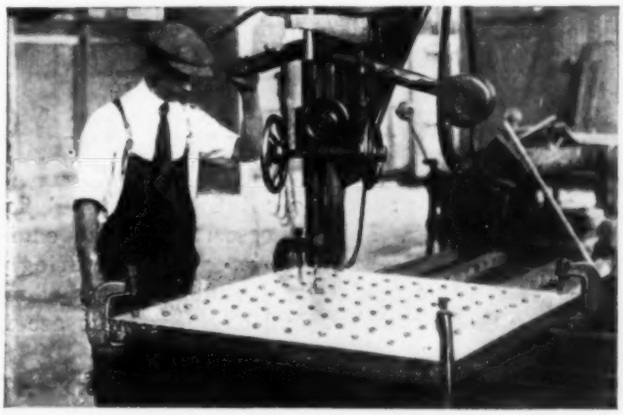
Plate Shelf Shop

In this department are constructed the shelves for our vacuum shelf dryers. Some of the operations in the manufacture of these shelves are shown on the opposite page.

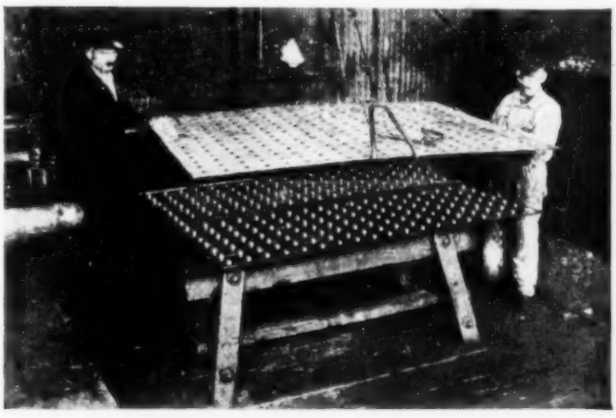
A Trip Through the Plant—*Continued*

Constructing Vacuum Dryer Shelves

The shelves are made of hydraulically straightened steel plates, great care being required to keep the plates from warping while going through the various operations of drilling, bending, welding, hot and cold riveting, testing, etc.



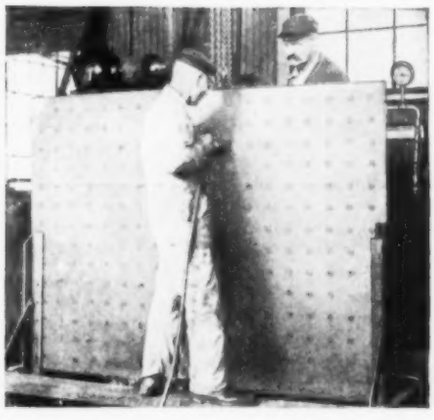
Drilling Plates to Template



Plates for Dryer Shelves, showing spacing blocks and rivets. Note large number used

Note particularly the large number of rivets used, the advantage of which is obvious considering the fact that the working pressure in the shelf may be up to 60 lbs. while a high vacuum is being maintained on the outside of the shelf within the dryer. These shelves are tested to 150 lbs. pressure.

Electric Welding Seams of Shelves



Re-riveting Shelves under pressure

Engineering and Consultation

The success of "Buflokast" and "Buflovak" equipment rests largely on the ability possessed by our engineering department to deal effectively with diverse manufacturing problems. With this in view our organization includes a corps of mechanical, chemical, vacuum and metallurgical engineers who are fully qualified for this work by experience and training.

Supplementing the services of our regular engineering staff, we offer the benefit of consultation with specialists occupying the foremost position in their respective fields.

Among the fields thus covered are the following:

Organic Chemicals,
Heavy Chemicals, Acids and High Explosives,
Caustic Soda, Potash and other Alkalies,
Vacuum Drying,
Evaporating,
Sugar Plants and Complete Sugar Refineries.

The professional advice of these men is backed by our exceptional facilities and the scientific control over the manufacturing processes in our laboratory-controlled plant.

We are also adding to our engineering and consulting staff as fast as new fields develop where our research and experience can be applied.

Experimental Work

Our Research Laboratories contain departments for conducting practical experiments in vacuum drying, evaporating, and in many of the chemical and mechanical operations of organic and inorganic chemistry. These experiments are conducted without charge or obligation, except for furnishing materials and paying transportation charges.

Complete Chemical Plants

An important feature of our work during the recent development of the chemical industry in America was our ability to furnish not only individual pieces of chemical apparatus, but complete plants for the manufacture of many chemical products.

In the pages describing our standard chemical apparatus will be found the names of various products for which we furnish complete manufacturing plants including the designing, construction and initial operation (under guarantee where desired); or we can supply apparatus for individual operations required in the production of these products, such as nitration, denitration, reduction, sulphonation, chlorination, distillation, crystallization, caustic fusion, etc.

Electrically Heated Apparatus

It sometimes becomes desirable to provide a heating medium different from that usually employed in our standard construction, especially where it is necessary to use a higher temperature than is obtainable at the maximum steam pressure for which the apparatus is constructed; or where a greater degree of control over the temperature is desirable. In such cases some of our apparatus is furnished with arrangement for being heated electrically.

Some of our apparatus to which electric heating can be applied include

Vacuum Drum Dryers	Impregnating Apparatus
Vacuum Shelf Dryers	Autoclaves
Vacuum Rotary Dryers	Fusion Kettles

Besides the advantage of convenience, higher temperature, and absolute temperature control secured by electric heating, there is the special advantage in some cases of portability. Where it is unnecessary for other reasons to fix the apparatus permanently in one place, it can be moved about as desired when arranged for electric heating.

BUFFALO FOUNDRY AND MACHINE COMPANY

Recovery of Waste Products

CONSIDERING the exceptional growth of the chemical and allied industries, it is more than ever necessary to give careful attention to the recovery of by-products and utilization of waste materials. Recovery plants are of national importance, not only from the economical but also from the sanitary point of view. Every day new problems arise close co-operation between owner and manufacturer is necessary to get the best results. We gladly place the facilities of our Research Laboratories at the disposal of our customers.

Some of the most important products to be recovered and waste materials to be utilized are:

Acids, Caustic Soda, Sulphates and Sulphites, in the Coal-Tar and Explosive Industries,

Caustic Soda in Mercerizing Plants,

Fats and Potash in Woolen Mills,

Fertilizers from Packing House and Fish Industries,

Cattle Feed from Breweries and Distilleries,

Potash from Sugar Waste,

Caustic Soda in Rubber Manufacturing Plants,

Tanning Liquors in Tanneries.

1547 FILLMORE AVENUE, BUFFALO, NEW YORK

Complete Extra Plants for Tannic Acids and Dyewoods

Complete plants are furnished for the extraction of tannins and coloring matter from raw materials such as chestnut, hemlock, logwood, quebracho, quercitron, sumac and others. Such plants include:

Chippers and Conveyors,

Leaching Batteries,

Settling and Storage Tanks,

Boilers, Coolers and Filters,

Evaporators,

Vacuum Drying Apparatus,

Barrel and Packing Machinery,

Power House Equipment.

Sizes and types of equipment are dependent on the kind and amount of wood or raw material to be treated, the kind of labor and fuel available and other local conditions, all of which should be fully specified when writing for specifications.

Particular attention is called to the demand for dry or powdered extracts which is due to the greater facility and economy with which they are used in the tanning and dyeing industries, and transported. Dry extracts manufactured with our vacuum dryers are gradually replacing the solid extracts manufactured in the old type finishing pans.

BUFFALO FOUNDRY AND MACHINE COMPANY

"Buflovak"

Sugar Apparatus
including
Complete Sugar Mills and Refineries

The Sugar Machinery Department is under the supervision of a specialist who has had many years' experience in designing, constructing and operating Sugar Machinery and entire Sugar Manufacturing Plants for producing brown, white and refined sugars in the cane and beet sugar fields.

Our organization also includes a corps of mechanical, chemical and metallurgical engineers providing such a measure of supervision over every detail of design and manufacture that efficient operation is amply assured.

The engineering and manufacturing facilities required for the production of our other lines are ideal for the manufacture of Sugar Machinery. With these facilities and our financial responsibility, our customers in the sugar industry are assured of receiving the same high standard of quality for which our other products are known.

Our facilities enable us to manufacture, assemble, and test machinery of any weight and size capable of rail or water transportation.

We furnish complete sugar plants or any part, according to our specifications or those submitted by customers.

1343 FILLMORE AVENUE, BUFFALO, NEW YORK

"Buflovak"

Sugar Apparatus
including
Complete Sugar Mills and Refineries

Hydraulic Sugar Cane Mills
Hydraulic Crushers and Pre-Crushers
Sulphurous Acid Generators
Sulphurous Acid Coolers

Heaters	Diffusion Batteries
Tanks	Pulp Catchers
Evaporators	Vacuum Pans
Catchalls	Vacuum Dryers
Condensers	Vacuum Pumps
Coolers	Steam Separators
Bag Filters	Sand Filters
Filter Presses	Bone Black Filters
Granulators	Bone Black Dryers

Kilns, Retorts, Mixers, etc.

A special catalog devoted to Sugar Machinery will be sent on request.

BUFFALO FOUNDRY AND MACHINE COMPANY

"Buflovak"
Vacuum Drying Apparatus

Vacuum Drum Dryers

Vacuum Shelf Dryers

Vacuum Rotary Dryers

Impregnating Apparatus

Dry Vacuum Pumps

Surface Condensers

Barometric Condensers

Expansion Tanks

Solvent Recovery Apparatus

1543 FILLMORE AVENUE, BUFFALO, NEW YORK

"Buflovak" Vacuum Drying Apparatus

Uses and Advantages

AN economical, safe, and positive means for drying all classes of materials is offered in "Buflovak" Vacuum Drying Apparatus. Materials that would be injured by excessive heat or can be dried otherwise only at prohibitive cost may be dried economically in "Buflovak" Dryers. An extremely low temperature is assured by the maintenance of a high vacuum in the apparatus. The drying is done very rapidly and materials can be dried in a few hours that otherwise would require days or weeks.

"Buflovak" Vacuum Dryers are also far more economical because of the extremely low operating cost and quick drying time. They enable the manufacturer to obtain an improved quality in the dried product. The low temperatures at which materials can be dried in "Buflovak" Dryers permit the drying of many materials, without injury or danger of overheating, that cannot be satisfactorily dried by any other method.

Some of the advantages of using "Buflovak" Vacuum Drying Apparatus

Low cost of operating.

Elimination of fire risk.

Cleanliness of operation.

Free from obnoxious odors.

Most rapid method of drying.

Saves floor space, steam and fuel.

Temperature under absolute control.

Valuable solvents may be reclaimed.

No overheating of sensitive materials.

Absolute dryness insured when desired.

Drying independent of climatic conditions.

Quality of dried products usually improved.

Materials dried at extremely low temperatures.

Produces a better and more uniformly dried material.

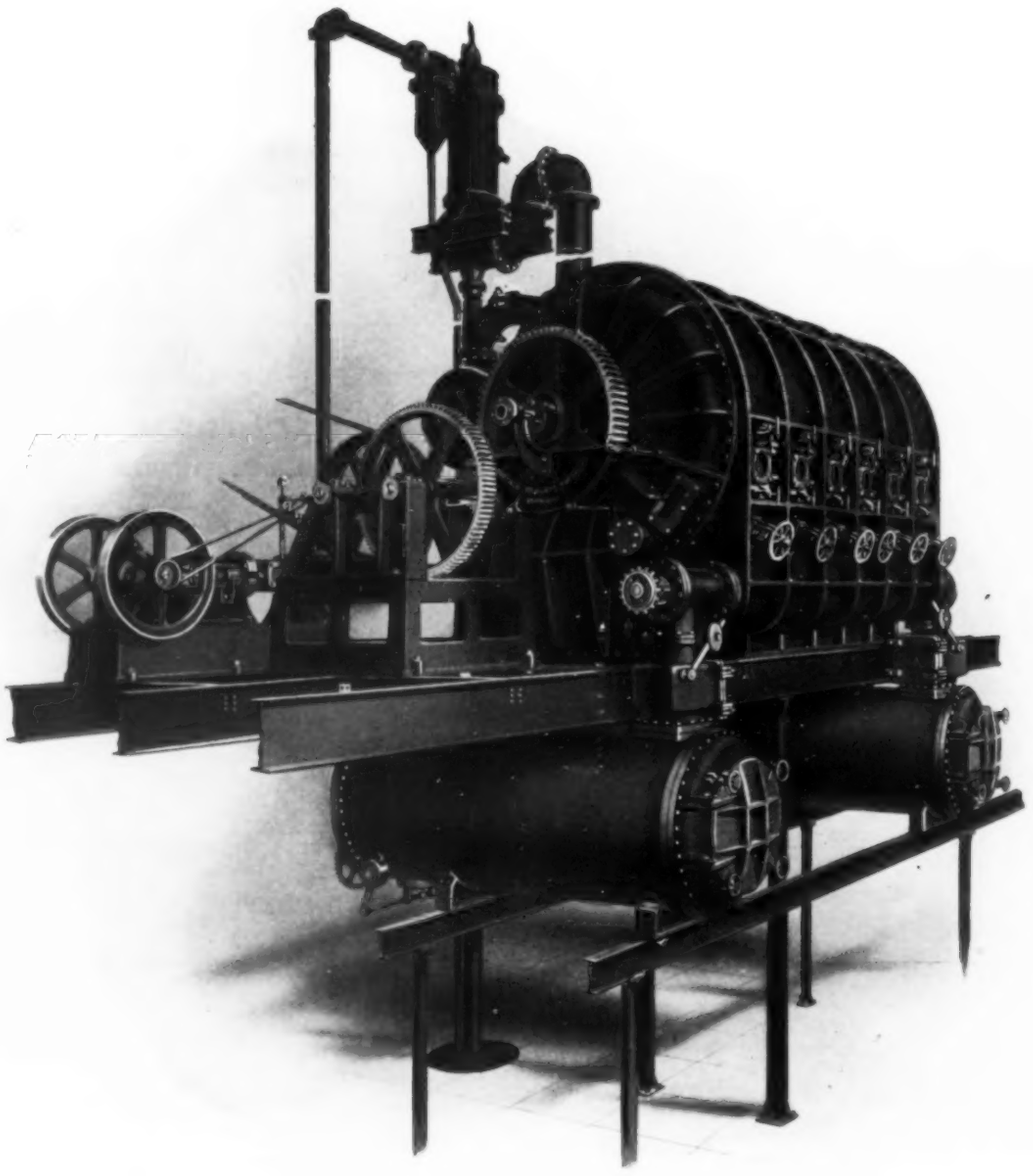
Dries materials that cannot otherwise be dried economically.

Dries materials in a few hours which otherwise requires days or weeks.

Eliminates the necessity of carrying a large stock of dried material or material in process of drying.

"Buflovak" Dryers are built for all materials and to suit any capacity desired.

BUFFALO FOUNDRY AND MACHINE COMPANY



"Buflovak" Vacuum Drum Dryer

Equipped, for continuous operation, with two receivers, vacuum pump, condenser, etc. This arrangement is used where the dry material can be mechanically conveyed.

1543 FILLMORE AVENUE, BUFFALO, NEW YORK

"Buflovak" Vacuum Drum Dryer

The ideal apparatus for converting liquids into a dry powdered or flake form. It is used for drying solutions, emulsions, and pulps, such as Dyewood Extract, Quebracho, White Lead, Glues, Milk, Acids, Chemicals, and other liquids containing solids.

This dryer consists of a hollow drum revolving in a sealed casing provided with devices for applying to and removing from the drum the material being treated, and for delivering the dry product to suitable receivers. The bottom of the chamber acts as a reservoir for the liquid. Agitators for mixing and coils for regulating the temperature of the material are provided when necessary. Steam or hot water is supplied to the interior of the drum. A high vacuum is maintained in the casing by means of a dry vacuum pump and the material is therefore dried at a low temperature. Moisture is removed by evaporation. A condenser is provided for condensing the vapors from the casing, and recovering them if desired.

The bottom portion of the dryer serves as a reservoir for holding a large quantity of the liquid material. Ample space is provided between the top surface of the liquid and the bottom of the drum to prevent foaming material reaching the drum. Agitators are provided for material requiring constant stirring. Coils are placed in the reservoir for heating or cooling the liquid when temperature regulation is desirable. The drum journals are supported in bronze bearings, and are equipped with suitable stuffing boxes, steam and drain connections. Observation glasses are provided for noting the interior operation of the dryer. Ample space between the drum and the casing is afforded in the larger dryers to permit interior parts being thoroughly cleaned with a scrubbing brush and cleansing material.

For products which are removed from the drum in powdered or granular form, two receivers are usually provided to enable the dryer to be operated continuously, a conveyor being employed to deliver materials to one receiver, while the other receiver is being emptied. For flaky materials which cannot be readily conveyed a single large receiver is used, and the drying operation suspended while the dry product is being unloaded and the vacuum again created in the emptied receiver.

While the vacuum drum dryer has, in theory, been considered the ideal apparatus for drying liquids, satisfactory commercial results were not attained until our patented devices and methods for applying the liquid to the drum were perfected. Where the drum dips into the main body of the liquid, constant level cannot be maintained on many materials, due to the agitation and foaming of the liquid. This constant change in level makes a corresponding change in the amount of drum surface dipping in the liquid, which varies the moisture content in the finished product, interrupts the continuous operation of the dryer, reduces the output, and increases the cost of operation.

Our patented automatic device for applying the liquid entirely overcomes this condition, produces a uniform coating on the drum, and a uniform dry product. A maximum output is obtained at a minimum cost for steam, power and labor. As the drum in drying does not come in contact with the main body of liquid, all liquid materials containing solids can be dried satisfactorily, regardless of whether they foam or not in a vacuum.

The "Buflovak" Drum Dryer enables the most delicate liquid materials to be converted into dry form at extremely low temperatures—thus removing all danger from overheating—and at a very low cost of operation. In most cases the dried material

Vaccum Drum Dryer—*Continued*

is delivered as a powder, thus eliminating grinders.

All sizes are so constructed that they may be easily cleaned and kept in sanitary condition, which is a vital consideration when handling food products. The smallest dryer is so constructed that the casing over the drum can be readily moved back on a track so that free access can be had to all parts of the interior. The larger types are so arranged in size and convenience that a man can enter the casing and scour all parts of the interior.

Other Special Features

In all "Buflovak" Drum Dryers the main body or chamber casting is made in one piece. This elimination of joints in the main casting provides greater freedom from leaks, and a more rigid construction. The cast iron drum used in the apparatus is made of a special air-furnace metal, of a mixture determined by chemical analysis. We also make the drums of bronze or other alloys when required for materials which attack, or are injured, by cast iron.

The method of applying the liquid to the drum is such that only a small part of the drum surface is in contact with the wet material, therefore we have a greater working area of the periphery of the drum, have less steam consumption, greater drying speed, larger output, and lower drying cost.

As the drum does not dip into the liquid, the necessity of using end scrapers, collars, or banking devices is eliminated. In our apparatus the material cannot come in contact with the ends of the drum.

The knife holder has a large bearing the entire length of the dryer. The knife is adjusted to the drum by a special device—controlled by a series of handwheels—which permits the most accurate and delicate adjustment to the drum.

A large liquid-sealed dust catcher is provided, making it impossible to lose any dry material which may arise in dust form. This dust catcher is so arranged that the material can be drained into the dryer without breaking the vacuum in the apparatus.

Electric Heating

"Bufiovak" Vacuum Drum Dryers can also be arranged for being heated electrically. See page No. 19.

Atmospheric Drum Dryer

Attention is also called to the fact that the same principles used in the construction of the Vacuum Drum Dryer are also used in the construction of our Atmospheric Drum Dryers, which are used for drying many liquid materials that do not require a vacuum, such as Sodium Benzol Sulphonate, Sodium Acetate, etc.

STANDARD SIZES OF VACUUM DRUM DRYERS

No.	Diameter of Drum	Length of Drum	Weight	Approximate Outside Dimensions		
				Length	Width	Height
1	24″	20″	16000 pounds	10′	8′	8′
2	48″	20″	32000 "	18′	10′	12′
3	48″	48″	44000 "	18′	12′	12′
4	60″	72″	70000 "	20′	24′	18′
5	60″	144″	100000 "	20′	30′	18′

Weights include complete apparatus and are approximate. Vacuum Pump and Condenser not included in above space. Apparatus is usually equipped with barometric condenser. Will furnish surface condenser if desired.

SPECIAL SIZES BUILT FOR SPECIAL CONDITIONS

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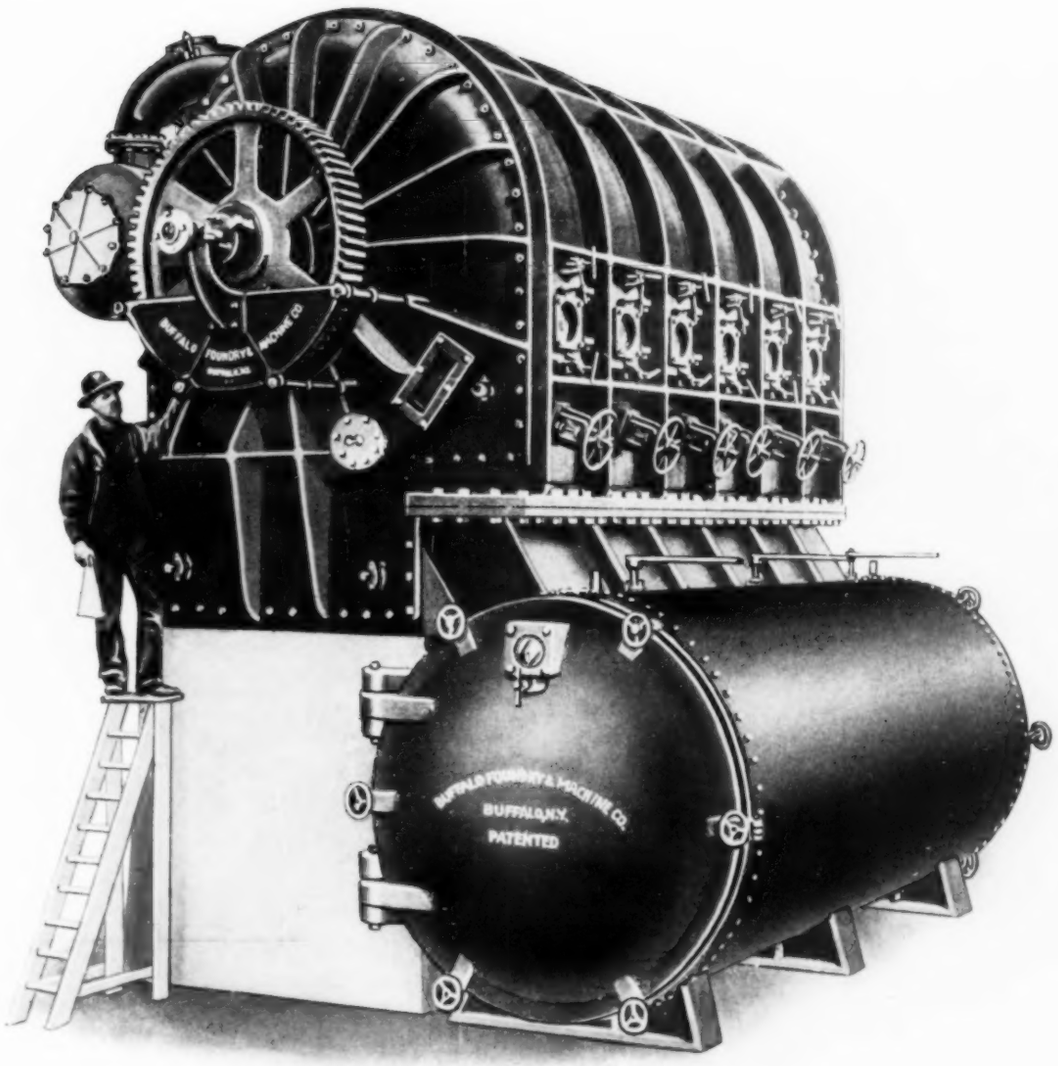
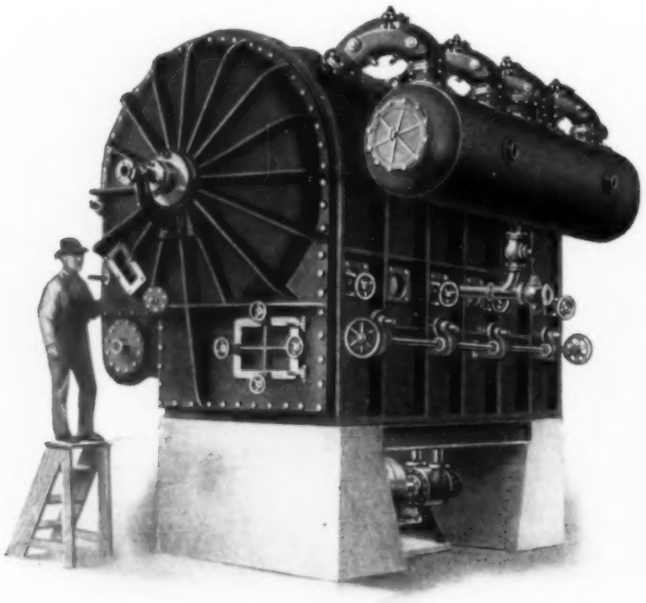


Vacuum Drum Dryer

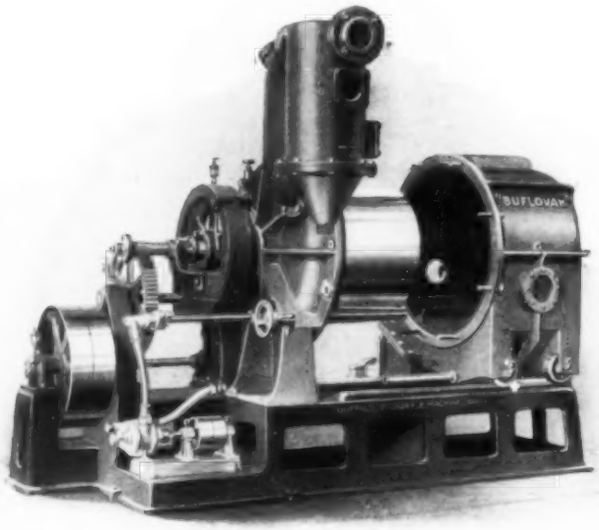
Equipped with one large receiver the full length of apparatus. Used on materials that will not permit mechanically conveyed when dry.

BUFFALO FOUNDRY AND MACHINE COMPANY



Vacuum Drum Dryer

Rear view, showing water sealed dust collector, vapor pipes, circulating pump, and method of returning material collected to dryer.



Vacuum Drum Dryer, No. 1 Size

This apparatus was developed for drying smaller quantities of liquids, pulps, etc., than could be handled economically in our large apparatus. The apparatus also makes a valuable laboratory drum dryer. It is built with casing, receiver, dust collector, etc., of cast iron, cast aluminum or cast bronze as required for different materials being dried.

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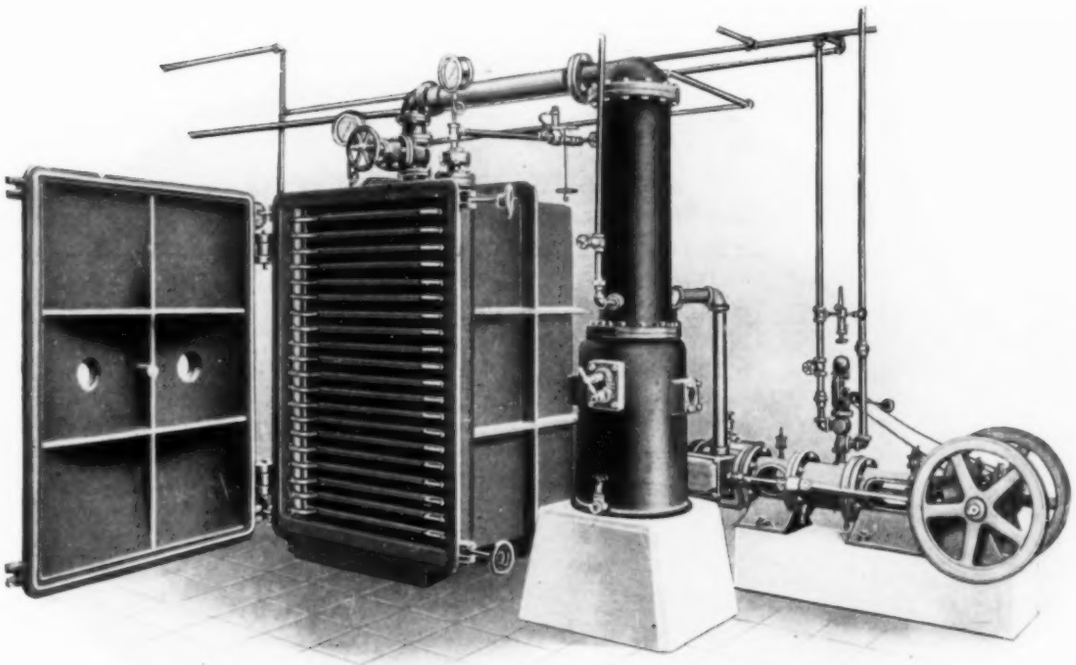

"Buflovak" Vacuum Shelf Dryer

The "Buflovak" Vacuum Shelf Dryer is adapted to the drying of any material that can be handled in pans or trays such as sheet and reclaimed rubber of all kinds, rubber compounds, paints, dyes, extracts, pastes, glue, soap, salts, albumens, of all descriptions, starch, glutrin, rosin, vegetables, fruits, sugars, small electrical apparatus, plates, chemicals, various by-products and liquid substances.

This dryer consists of a rectangular chamber containing hollow shelves, steam or hot water heated, on which are placed the pans or trays containing the material to be dried. The apparatus is then closed, the vacuum produced, and the drying commenced. If desired, the volatile matter or solvents removed from the material may be reclaimed. This type of dryer is used very extensively in many industries and is adapted to the drying of a large class of materials.

With the apparatus is furnished a vacuum pump and condenser, to produce and maintain a high vacuum during the drying operation. If the drying is to be done at an extremely low temperature, hot water is used as a heating medium, in which case we supply the apparatus with a hot water circulating system.

Special Features

A distinctive feature of the "Buflovak" Shelf Dryer is the construction of the chamber casting, which, in all sizes is

BUFFALO FOUNDRY AND MACHINE COMPANY

Vacuum Shelf Dryer—*Continued*

made in one piece. This eliminates many joints which would otherwise be necessary. The metal used is a special quality of air furnace iron known as "gun-iron," a dense, homogeneous metal, high in tensile strength; qualities that are essential in the construction of dryers for high vacuum work.

The heating shelves are made of hydraulically straightened steel plates, joined together by seamless welds. Baffle plates are placed between the upper and lower plates of shelves to insure such distribution of the steam that the shelves will be uniformly heated throughout. All shelves are constructed for a working pressure of 60 pounds and tested to 150 pounds pressure before being assembled in the dryer.

The steam manifolds are made of XX steel pipe, avoiding the breakage experimaking it easy to disconnect or connect a shelf at any time it is found necessary. The manifolds are connected to the shelves with ground joints, which eliminates the use of packing.

Expansion and contraction of the shelves are taken care of both endways and sideways, and it is impossible to throw any strain, through this cause, on the manifolds or shelves.

To break the vacuum, a four-way cored opening is contained on the inside of the door, which evenly distributes the incoming air over the apparatus and does not permit blowing of the material being dried.

Electric Heating

"Buflovak" Vacuum Shelf Dryers can also be arranged for being heated electrically. See page 19.

TABLE OF STANDARD SIZES

	Width of Shelf	Length of Shelf	Number of Shelves	Spacing	Pan Surface	Number of Shelves	Spacing	Pan Surface	Number of Shelves	Spacing	Pan Surface	Number of Shelves	Spacing	Pan Surface	Number of Shelves	Spacing	Pan Surface	Number of Shelves	Spacing	Pan Surface	Number of Shelves	Spacing	Pan Surface	Number of Shelves	Spacing	Pan Surface	Weight of Dryer See Note Below	
A	18	18	1	4½	2½																						800	
B	24	24	2	5½	4	3	2½	8																			1100	1175
C	42	42	3	6½	22	4	4½	33	5	3 1/16	44	6	2½	55													3800	4450
D	42	42	6	5	55	7	4	66	8	3½	77	9	2½	88	10	2½	99										5600	6470
E	42	42	8	6	77	9	5	88	10	4½	99	11	4	110	12	3 1/16	121	13	3	132	15	2 1/16	154				7430	8970
F	42	42	11	5½	110	12	5	121	13	4½	132	14	4	143	16	3½	165	17	3	176	20	2½	209				8650	10650
G	60	80	9	5½	240	10	4½	270	11	4½	300	12	3½	330	13	3½	360	14	2½	390	15	2½	420	16	2½	450	19500	23750
H	60	120	9	5½	360	10	4½	405	11	4½	450	12	3½	495	13	3½	540	14	2½	585	15	2½	630	16	2½	675	26000	32200
I	60	160	9	5½	480	10	4½	540	11	4½	600	12	3½	660	13	3½	720	14	2½	780	15	2½	840	16	2½	900	33000	41600
J	60	80	12	5	330	13	4½	360	14	4	390	16	3½	450	18	3	510	19	2½	540	20	2½	570				23000	27900
K	60	100	12	5	412½	13	4½	450	14	4	487½	16	3½	562½	18	3	637½	19	2½	675	20	2½	712½				26800	32500
L	60	120	12	5	495	13	4½	540	14	4	585	16	3½	675	18	3	765	19	2½	810	20	2½	855				31100	38200
M	60	140	12	5	577½	13	4½	630	14	4	682½	16	3½	787½	18	3	892½	19	2½	945	20	2½	997½				35500	43900
N	60	160	12	5	660	13	4½	720	14	4	780	16	3½	900	18	3	1020	19	2½	1080	20	2½	1140				39850	49600

Shelf Dryers are designated by the class letter followed by the number of shelves. Example: "F-20" designates an "F" dryer with 20 shelves. The dimensions of the shelves and the spacing between the same are given in inches; pan surface in square feet.

The spacing and number of shelves may be changed up to the limit of the chamber.

The weights given in the last two columns are for the dryer with the lowest and highest number of shelves respectively.

All shelves are 1 inch thick, excepting the "A" size, which is steam jacketed.

All dryers from "A" to "F" inclusive have one door. All dryers from "G" to "N" inclusive have two doors, one at each end of the dryer.

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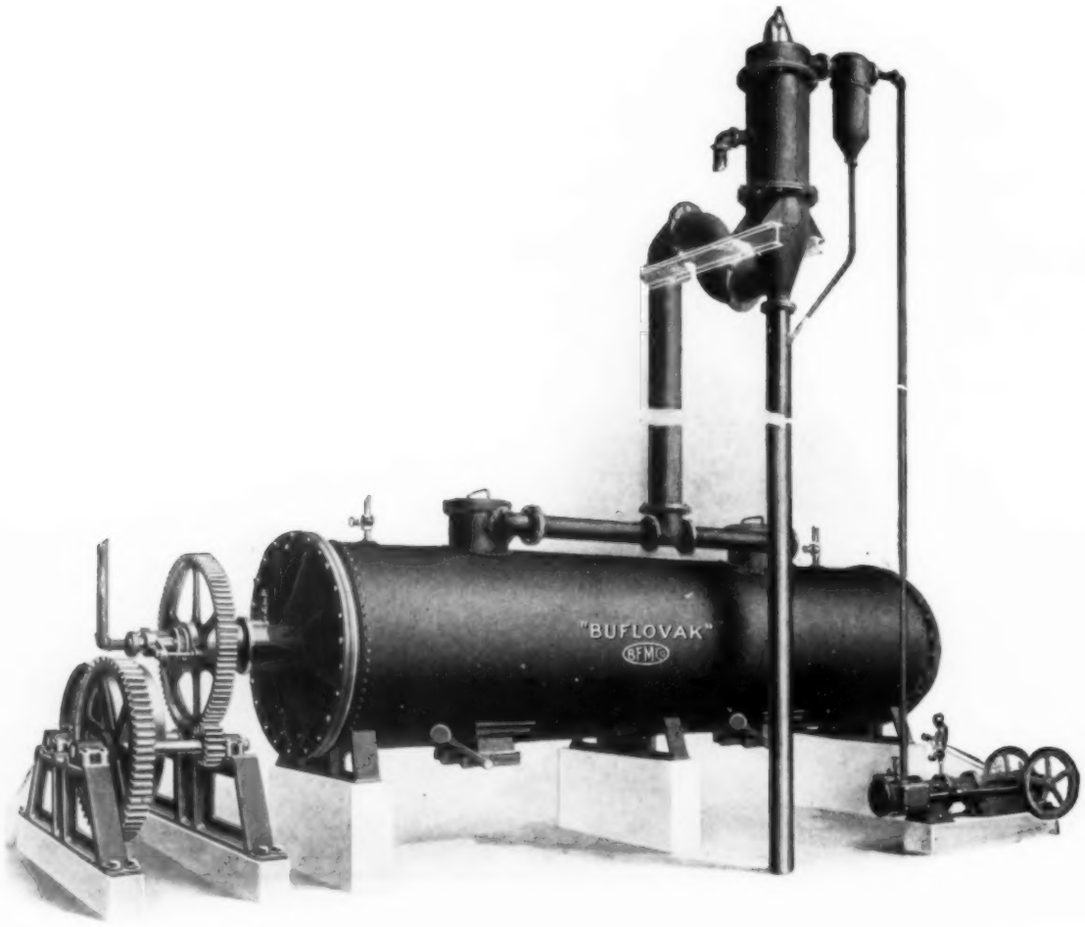
"Buflovak" Laboratory Vacuum Shelf Dryer

In this dryer the center of the stand forms the condenser, and the base a receiving chamber for condensed vapors. An efficient apparatus for laboratory work. Takes pan 18″ x 18″. Any results obtained in this apparatus, per square foot of pan surface, can be duplicated in any of our larger shelf dryers. The apparatus is frequently used to determine the size dryer required for a given work, and the depth and amount per square foot to load pans, trays, etc. This dryer can be arranged for electric heat, thus making an ideal arrangement for laboratory use, permitting the dryer to be moved about as desired. See page 19.

"Buflovak" Vacuum Shelf Dryer

Loaded for shipment. Approximate weight, 47,000 pounds. Note that the chamber is made in one piece, a distinctive feature of all "Buflovak" Shelf Dryers.

BUFFALO FOUNDRY AND MACHINE COMPANY



"Buflovak" Vacuum Rotary Dryer

Complete with Vacuum Pump, Barometric Condenser, etc.

The Vacuum Rotary Dryer is used for drying semi-liquids and materials in granular form, such as reclaimed rubber, rubber compounds, chemicals, by-products, starch, cereals, fertilizer, dextrine, or any material that permits tumbling or mixing while being dried.

The dryer consists of a hollow, steam-jacketed cylinder fitted with heads at each end. In the center of the cylinder is a revolving heating tube carrying arms and paddles which effect a tumbling over or mixing of the material being dried. The dryer can be operated in connection with a barometric or surface condenser, depending on the amount of moisture or solvents being drawn from the material under treatment and also whether or not it is desired to reclaim them.

In operation steam is supplied to the jacket of the casing and to the inner revolving tube. After being loaded with the

"Buflovak" Vacuum Rotary Dryer—*Continued*

material to be dried, the space between the revolving tube and the jacketed shell is evacuated. The vacuum causes a rapid evaporation of the moisture and other solvents contained in the material. The vapors pass to the condensers where they are condensed and either thrown away or reclaimed as desired.

A distinctive feature of the "Buflovak" Rotary Dryer is the construction of the jacketed shell and the inner revolving tube. These are made of lap-welded steel tubing instead of the welded or riveted steel plate construction. The lap-welded construction, being more regular and free from joints or rivets, permits the paddles to be set close to the shell, and greatly increases the efficiency of the dryer.

For drying most materials the outer casing consists of the construction above described, but for materials which tend to adhere to the shell, the outer casing is made of cast gun-iron, cast with a jacket between two shells. This construction permits the inside to be machined the full length. This is done so that the paddles or scrapers can be set close to the shell to prevent material adhering to the shell while drying.

For loading, the dryer contains one or more large openings at the top which are fitted with cast iron covers. When necessary these covers are also supplied with an observation glass. The unloading apertures, one or more in number, are placed at the bottom of the shell. These consist of doors, properly hinged and counterbalanced. The doors are flush with the inner shell of the dryer so that no material can lodge in the unloading apertures when the doors are closed. Any of our dryers will unload the charge in a few minutes, but for ease in loading and unloading, it is desirable to so place the apparatus that it can be charged from, and discharged into hoppers, which can be connected with conveying devices, etc.

The "Buflovak" Rotary Dryer is frequently used as and makes a very efficient percolator, mixer, evaporator, cooker, etc. Where cooking is desired prior to drying, the same may be accomplished by doing the cooking before a vacuum is created in the apparatus. After it is cooked, the material can be dried in the same apparatus.

Electric Heating

"Buflovak" Vacuum Rotary Dryers can also be arranged for being heated electrically. See page 19.

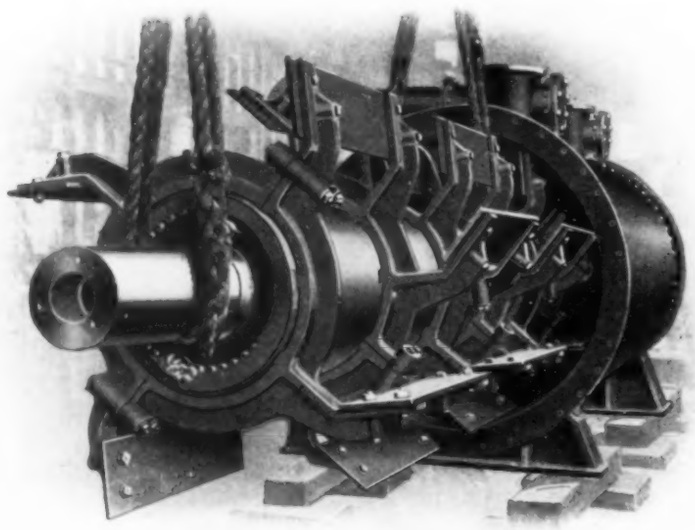
TABLE OF STANDARD SIZES

Size	Inside Diameter	Inside Length	APPROXIMATE OUTSIDE DIMENSIONS			Approximate Weight
			Length	Width	Height	
R- 1	2′	4′	7′	4′	5′	1800 lbs.
R- 2	3′	6′	10′	7′	8′	10500 "
R- 3	3′	10′	14′	7′	8′	14500 "
R- 4	3′	15′	19′	7′	8′	19000 "
R- 5	3′	20′	25′	7′	8′	24000 "
R- 6	5′	10′	17′	10′	11′	23000 "
R- 7	5′	15′	22′	10′	11′	30000 "
R- 8	5′	20′	28′	10′	11′	38000 "
R- 9	5′	25′	33′	10′	11′	46000 "
R-10	5′	30′	39′	10′	11′	55000 "

SPECIAL SIZES BUILT FOR SPECIAL CONDITIONS

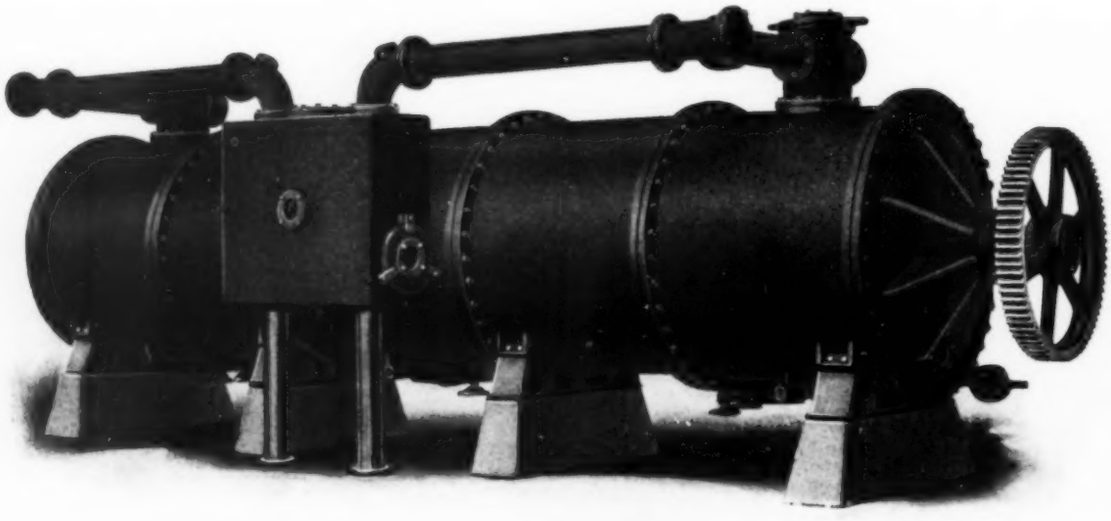
The above outside dimensions allow for a foundation of sufficient height to open the unloading doors above the floor, except the 2′x4′, which is placed on cast iron stands of the proper height.

The weights given are for steel tube construction. If cast iron shell is used, weight will be heavier.



Interior of Vacuum Rotary Dryer

Showing center heating tube, carrying paddles.
Note heavy, rigid, durable construction.



Vacuum Rotary Dryer

With cast iron outer jacketed casing. Used for materials which tend to adhere to shell, such as garbage, etc. By making the casing of cast iron, the construction is exceptionally rigid and permits the inside to be machined the full length. This is done so that the paddles or scrappers can be set close to the shell to prevent any material from adhering to the same while drying.

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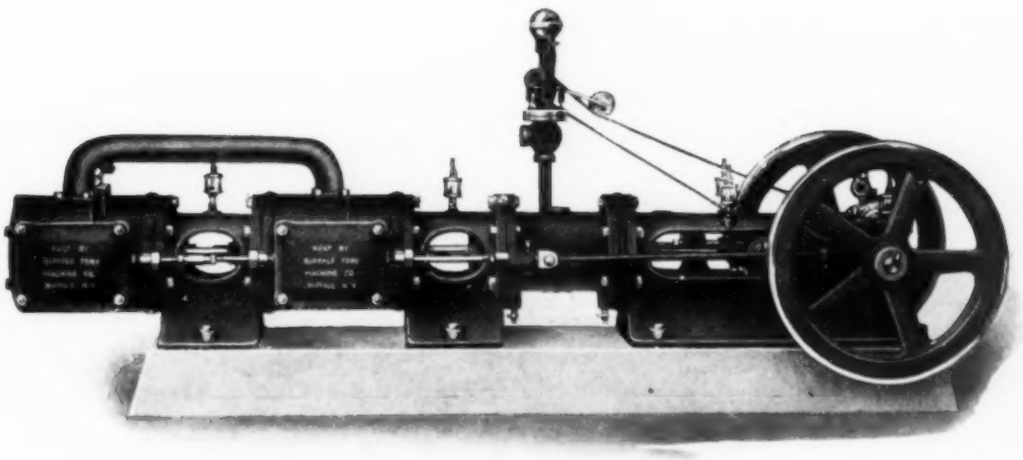
"Buflovak" Dry Vacuum Pumps



Two Stage, Steam Driven

The efficiency of a vacuum apparatus depends largely upon the vacuum pump. Rapid evaporation at a low temperature necessitates the maintenance of a high vacuum. "Buflovak" Pumps are designed and built with this end in view.

All our pumps are of the straight line flywheel type, with mechanically operated slide valves. Air valves are self-seating, without springs, and embody special features, including a specially constructed by-pass for rarefying the air left in the clearance space at the end of the stroke. The air valve is also fitted with a unique silent plate exhaust valve in place of the old style poppet valve. This exhaust valve has a long lift, is very efficient, and is absolutely noiseless in operation, whereas the old style poppet valve has a very short life, is noisy and causes considerable trouble from breakage.

The air cylinders are cooled by water jackets. This assists in the production and maintenance of an extremely high vacuum. Air pistons are fitted with three rings, and the steam pistons with two. All bearings are of a high grade bronze or babbitt-metal, of ample proportions and are adjustable for wear, thus insuring a long wearing quality.

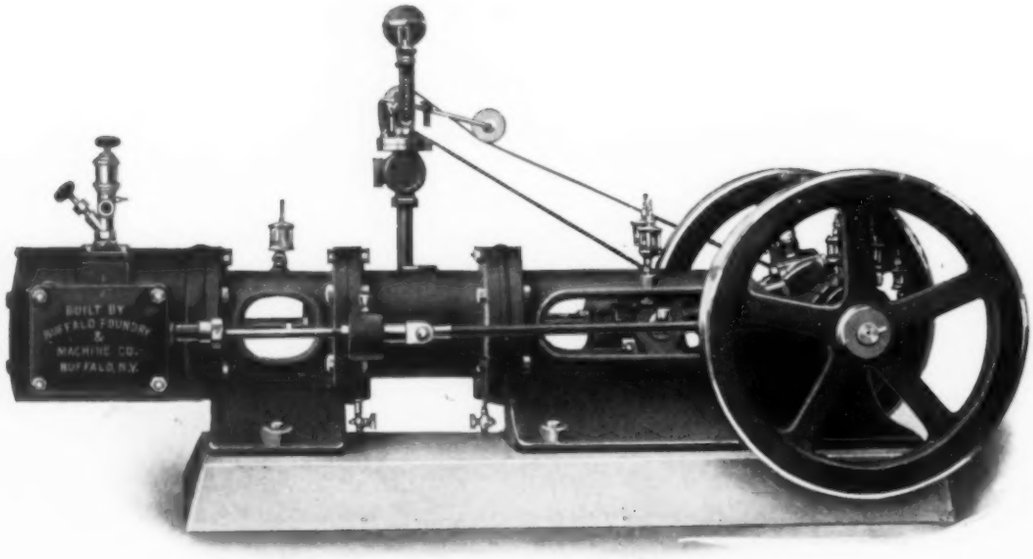
The positive length of stroke, together with the positively operated valves, allow as high a rotative speed as is consistent with good practice in any reciprocating type of steam engine.

A low steam consumption is made possible by an early cut-off, which is obtained by this type of pump.

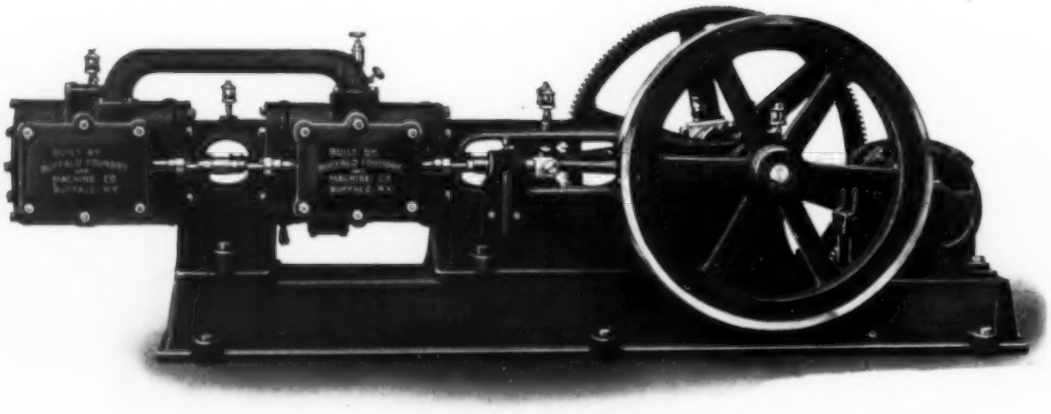
"Buflovak" Dry Vacuum Pumps are built in various sizes, horizontal and vertical; single and two stage; steam, belt and motor driven. Table of sizes on page 39.

BUFFALO FOUNDRY AND MACHINE COMPANY

"Buflovak" Dry Vacuum Pumps



Single Stage, Steam Driven



Two Stage, Motor Driven

This cut shows method of attaching motor and sub-base to any of our horizontal two stage pumps.

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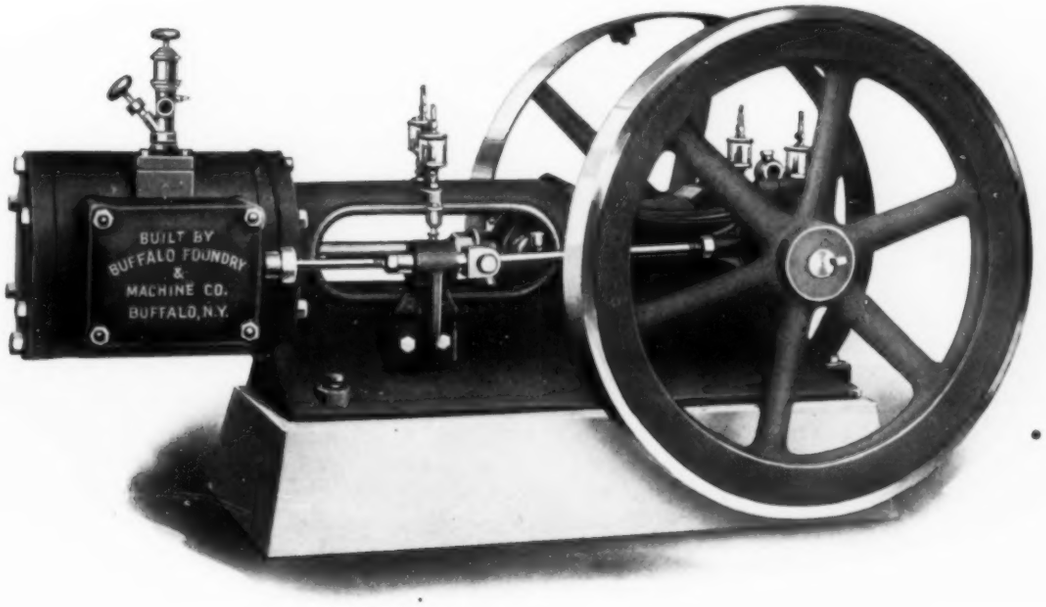
"Buflovak" Dry Vacuum Pumps



Single Stage, Belt Driven

STANDARD SIZES OF DRY VACUUM PUMPS

Bore of Steam Cylinder on Steam Driven Pumps	Bore of Air Cylinder	Stroke	Cubic Feet of Free Air per Minute	R.P.M.	Suction	Discharge	Diameter of Fly-Wheel	SIZE OF PULLEY ON BELT DRIVEN PUMPS	
								Dia.	Face
*4	5	5½	11	100	1¼″	1¼″	18″	24″	4″
7	8½	7	45	100	1½″	1½″	24″	30″	4″
7	10	10	90	100	3″	2½″	36″	36″	6″
7	12	10	130	100	3″	3″	36″	36″	8″
8	12	12	157	100	3½″	3″	36″	48″	8″
8	14	12	211	100	5″	3″	48″	54″	8″
10	16	12	276	100	6″	4″	48″	60″	8″
10	16	16	367	100	6″	4″	56″	60″	8″
10	18	16	463	100	8″	6″	56″	72″	8″

*The first pump listed is of the Vertical type. All others are of the Horizontal type.
All pumps are furnished in the belt driven, steam driven, or motor driven types.
All pumps are furnished in the two-stage type, when desired, in which case the second air cylinder is the same size as the one given in the table.

BUFFALO FOUNDRY AND MACHINE COMPANY

"Buflovak" Surface Condenser

Consists of tube cylinder filled with brass tubes, mounted on a receiver; the vapors condensing inside the tubes, the cooling water surrounding the outside of tubes. All parts of this condenser are readily accessible, easy to clean or remove any sediment or deposit left by impure or dirty water in the water section. The condenser is so arranged that the amount of condensation taking place, and also the amount contained in the receiver, may be noted by the operator. The receiver can be drained whenever desired, without retarding or interfering with its operation. The expansion and contraction of the tubes and other parts, due to the changes in temperature are provided for. A large tube area is provided, and as large a receiver as is consistent with this type condenser. These condensers are built standard in the vertical type, but may be constructed horizontal or otherwise, if desired. Sizes to suit requirements.

"Buflovak" Barometric Condenser

This type of condenser is used where large quantities of vapor are to be handled, and where the vapors which have no commercial value may be mixed with the cooling water. Normally this condenser should be placed about thirty-five feet (35′) from the bottom flange to the water in the hot well, depending on the barometric pressure at the location where it is to be installed. These condensers are provided with our patented adjustable spray opening, which governs the amount of water entering the condenser, and prevents the clogging of the water supply by foreign matter. In starting, the water may be turned on full, then the adjustment made at the exterior of the condenser, while same is in commercial operation. This patented condenser, is exceptionally efficient and economical, and is built in many sizes.

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"Buflovak" Surface Condenser Without Receiver

This condenser consists of a tube section. The hood at the top is provided with two openings, one for the air and vapors to enter, and the other for the exhaust. These openings enter into compartments at the top, which are divided by a wall, causing any air, vapors or gases entering one pipe to be forced down through a number of the tubes to the bottom of the tube section, and return through the balance of the tubes to the top, at which point the air, separated from the vapor, leaves the condenser. This condenser is usually placed vertically, but may be used horizontally if desired. Where it is used in a vertical position, it is supplied with legs for supporting it at a sufficient height above the floor to permit placing a container underneath, in which liquids may be reclaimed from the condenser and the container easily removed from the bottom of the condenser. The legs or stands may be left off and the condenser drain piped where desired.

"Buflovak" Expansion Tank

Used in connection with a dry vacuum pump, to collect and reclaim highly volatile vapors, which sometimes pass through the cylinder of the vacuum pump with the exhaust air from a vacuum apparatus. These expansion tanks are built in various sizes.

"Buflovak"
Vacuum Drying and Impregnating Apparatus

Used for drying under vacuum, and impregnating with insulating compound, electric coils, cables, transformers, armatures and other electrical work; for impregnating any material with paraffine, creosote, oils, colors, waterproofing compounds, and other liquids; for impregnating wood with stain or color, making imitations, which escape detection, of mahogany, cedar and other woods.

The apparatus consists of two or more tanks heated by steam, gas or oil, the tanks being connected at the bottom. Attached to the tanks are a condenser and vacuum pump. The illustration shows our cast gun iron steam-jacketed type, cast in one piece with jacketed side and bottom. This construction eliminates all interior joints and insures a smooth inside surface. The apparatus is so arranged that additional tanks may be added to the installation whenever desired, all being connected to the same pump and condenser. When desired the liquor tank is equipped with a stirring device.

The materials to be treated are placed in the impregnating tank and are rapidly dried under vacuum. After the air and moisture are removed from the pores of the material the compound is admitted to the liquor tank until the material is thoroughly covered, after which the compound is forced into the evacuated pores under pressure until they are thoroughly filled. The material being treated may then be taken out or, if desired, redried under vacuum. Any valuable solvents may be reclaimed. Built in various sizes.

Electric Heating

"Buflovak" Impregnating Apparatus can also be arranged for being electrically heated. **See page 19.**

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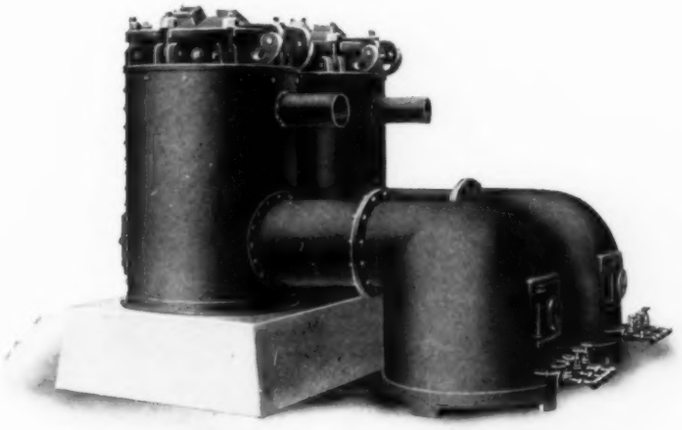
"Buflovak"
Vacuum Drying and Impregnating Apparatus

Steel plate construction, welded where possible. Complete with condenser, horizontal vacuum pump, cover hoisting device, stirring device and center heater in liquor tank. Built with either steam jacket, or coils on inside of tanks as a heating medium.



Gas-Heated type. Note that the heating chambers, containing the gas burners, are a sufficient distance from tanks containing compound, to prevent ignition of compound, should a leak occur in the tanks. Indirect radiation is used to liquify compound and for drying. An ideal apparatus where steam is not available.

Vacuum Drying Problems

Data Required

Correspondence will be facilitated if full information is given when drying problems are submitted to us. Correspondents are therefore requested, when presenting their problems, to give us all the information available, particularly the following:

1. Description of the material to be dried.
2. Amount of dry material to be produced daily.
3. State the number of hours per day the dryer will be operated.
4. Average percentage of moisture contained in the material previous to drying.
5. Percentage of moisture permissible in dry material.
6. Weight of material per cubic foot in wet state.
7. Highest permissible temperature in drying.
8. State whether the material is acid, alkaline or neutral.
9. Is material injured by contact with cast iron or steel? If so, specify the metals that can be safely used.
10. Is the material inflammable, poisonous or otherwise dangerous?

Testing Laboratory

Drying tests can be conducted in our Research Laboratory without charge or obligation, provided the materials are furnished and transportation charges paid.

1543 FILLMORE AVENUE, BUFFALO, NEW YORK

"Buflovak" Evaporators

Horizontal Tube Evaporators

Vertical Tube Evaporators

Rapid Circulation Evaporators

All Cast-Iron Evaporators

Crystallizing Evaporators

Basket Type Evaporators

High Concentrators

Causticizing Apparatus

Caustic Soda Plants

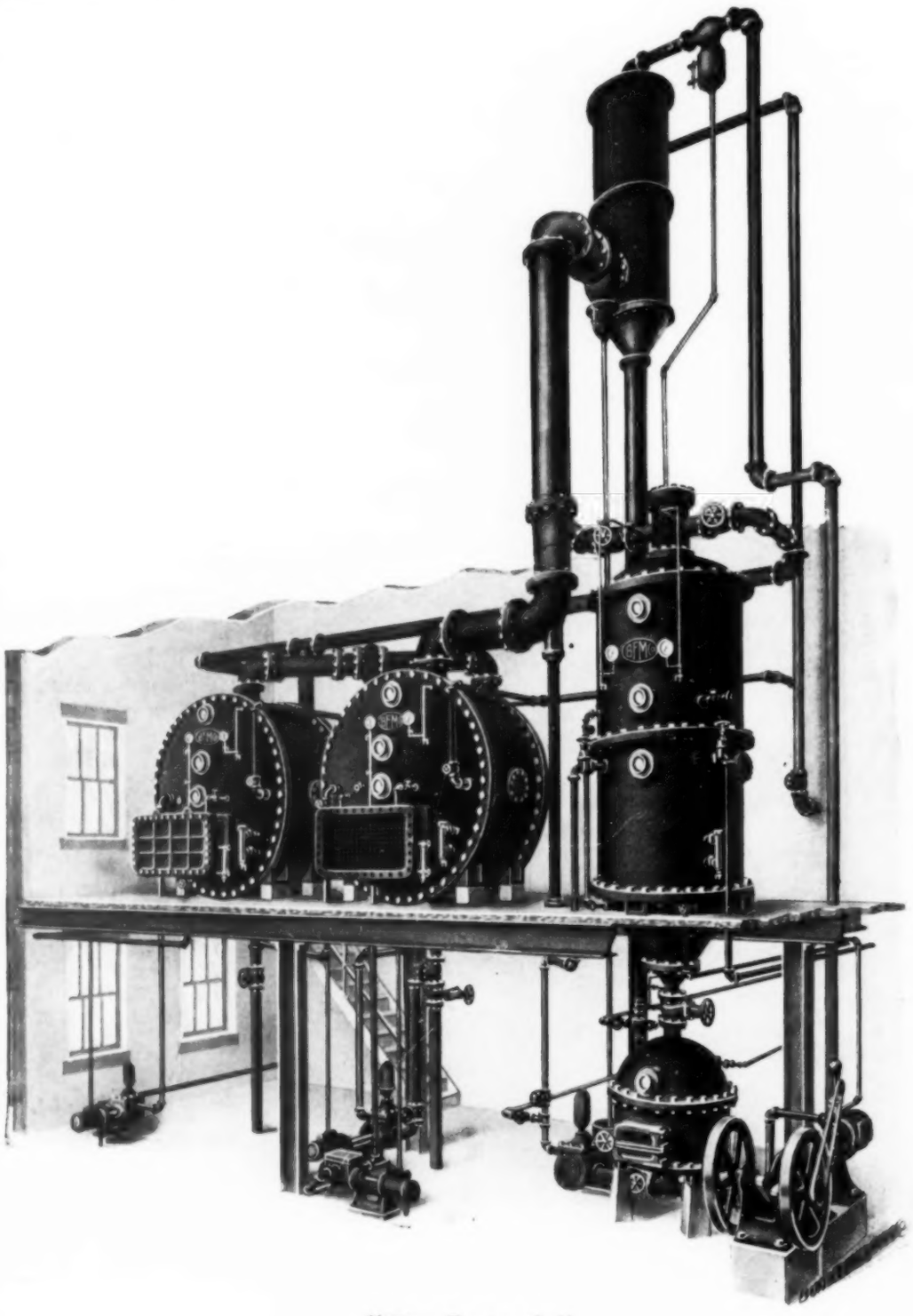
Caustic Recovery Apparatus

Waste Product Machinery

Receivers, Salt Filters,

Pre-heaters, etc.

BUFFALO FOUNDRY AND MACHINE COMPANY



"Buflovak"
Triple Effect Evaporator

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"Buflovak" Evaporators—*Continued*

The concentration of solutions by evaporation is one of the most important operations in the chemical industries, and influences to a considerable extent the success of such enterprises.

Evaporation may be effected by direct heat, i.e., coal, oil or gas; by waste heat from boilers or furnaces; by direct steam coming from high or low pressure boilers; or waste (exhaust) steam previously utilized in engines or turbines. In some cases solutions are concentrated by exposing them to the sun (solar evaporation) or by bringing the liquid in contact with a current of hot air or water gases. Without doubt the most economical method is the evaporation by the use of steam in multiple effect, with or without the use of vacuum. Wherever possible exhaust steam and vacuum should be used as such an arrangement will produce the greatest fuel economy and reduce the cost of repairs.

On account of the great variety of liquids to be treated, it is impossible to build one standard type of apparatus that will handle all classes of solutions. Considering the chemical and physical properties of the various liquors to be evaporated, at least four distinct types of apparatus should be used:

First:—Horizontal Tube Evaporator for common solutions which are to be distilled or concentrated to a higher density without the separation of salts, and which have no tendency to foam or produce scale. A standard vertical tube evaporator may also be used for this purpose.

Second:—Rapid Circulation Evaporator of the vertical or inclined type for common solutions which are to be distilled or concentrated to a higher density without the separation of salts, but which have a tendency to foam or produce scale. Also used for delicate liquors which should be exposed to the heat for a short time only.

Third:—Vertical Tube Evaporator of the crystallizing type with salt filters, for solutions containing salts which become insoluble during the concentration.

Fourth: — High Concentrator of the special vertical tube type for liquors which, on account of their high boiling point or increased viscosity, require a high steam pressure combined with quick circulation.

In some cases it is advisable to use two or more types of evaporators for the different stages of the evaporating process as for instance in the manufacture of caustic soda from soda ash where the Horizontal or Rapid Circulation Type is used for the concentration to 36° Be., the Vertical Type to 48° Be., and the High Concentrator to 67° Be.

The design of all "Buflovak" Evaporators is based on the thorough knowledge and special experience of our engineers; all details have been carefully worked out and they will meet the following important requirements:

Mechanical strength, high quality of material, and ample thickness of metal for all important parts.

Uniform circulation of the boiling liquid in order to prevent coating of the tubes.

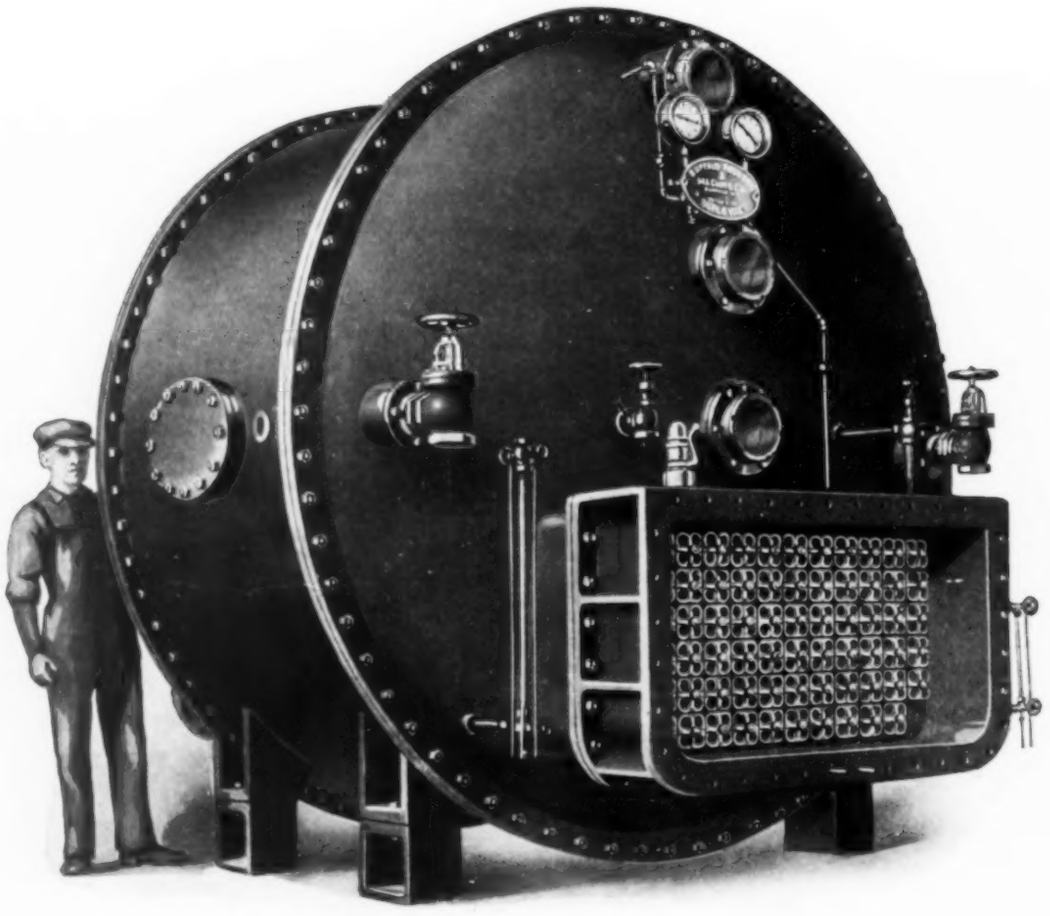
Proper distribution of the steam over the whole heating surface.

Proper proportions of the evaporator so as to avoid losses by entrainment and foaming.

Simple construction so that the equipment can be operated, and if necessary, repaired by unskilled labor.

Evaporators which come up to this standard cannot be cheap in first cost, but the extra money spent will soon be repaid by the low cost of operation and repairs. In other words they are

BUFFALO FOUNDRY AND MACHINE COMPANY



Front View

"Buflovak"
Horizontal Tube Evaporator

1543 FILLMORE AVENUE, BUFFALO, NEW YORK

"Buflovak" Horizontal Tube Evaporator

This type of construction has been developed from the old "Wellner-Jelinek" evaporator which was designed more than sixty years ago for the concentration of beet sugar juice. The former rectangular shell made of straight plates has been changed to a circular shell. The advantages are obvious.

Fig. 1 shows the general construction of the "Buflovak" H. T. Evaporator. The horizontal cylindrical shell is closed at both ends by spherical heads, and the evaporator body will therefore resist any inside or outside pressure, without the necessity of excessive wall thicknesses. The number of joints and therefore the chance for leakage is less than in any other type, as the cylindrical shells can be made in one piece up to a length of 12 feet.

Rectangular shaped steamheaders are bolted to the spherical heads and the heating tubes are secured in cast iron flue plates by taper shaped rubber gaskets and bolted packing plates, or expanded in steel flue plates like ordinary boiler tubes. The rear header is slightly higher than the front header so that the condensation in the tubes will readily drain towards the front. The steam enters the rear header through a manifold on top, making it possible to distribute the steam or vapor evenly over all the tubes. The front header has an outlet for the condensation at the bottom, and an opening at the top for the removal of the non-condensable gases.

At each side of the rectangular nest of heating tubes is placed a partition plate. Width of the tube nest and diameter of the evaporator are of such proportions that a large downtake of uniform width is left on both sides. The liquor boiling up between the tubes is given a chance to return to the bottom of the evaporator through the downtake, permitting a rapid and uniform circulation through all parts of the heating surfaces. The liquor passes

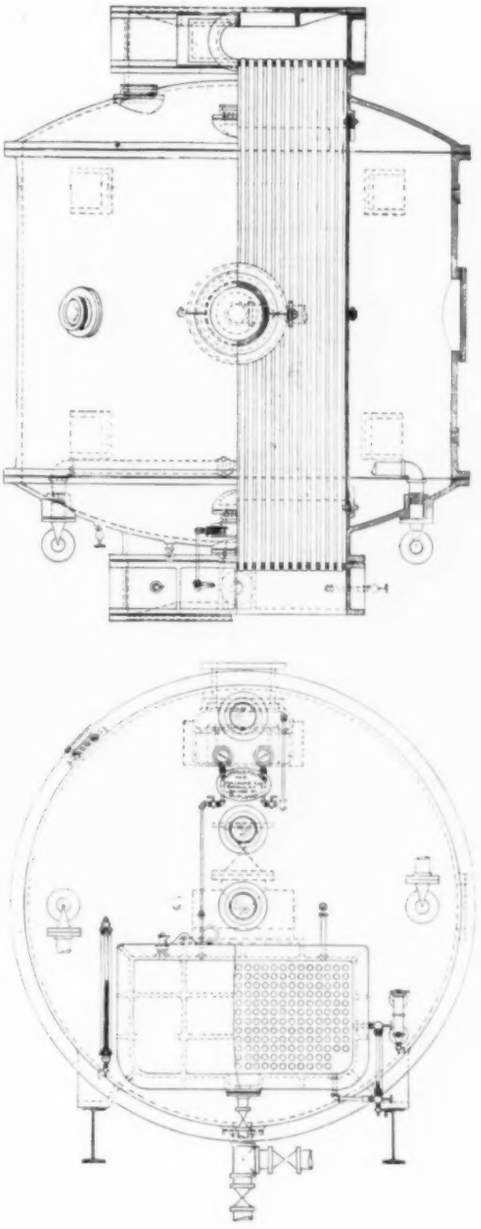
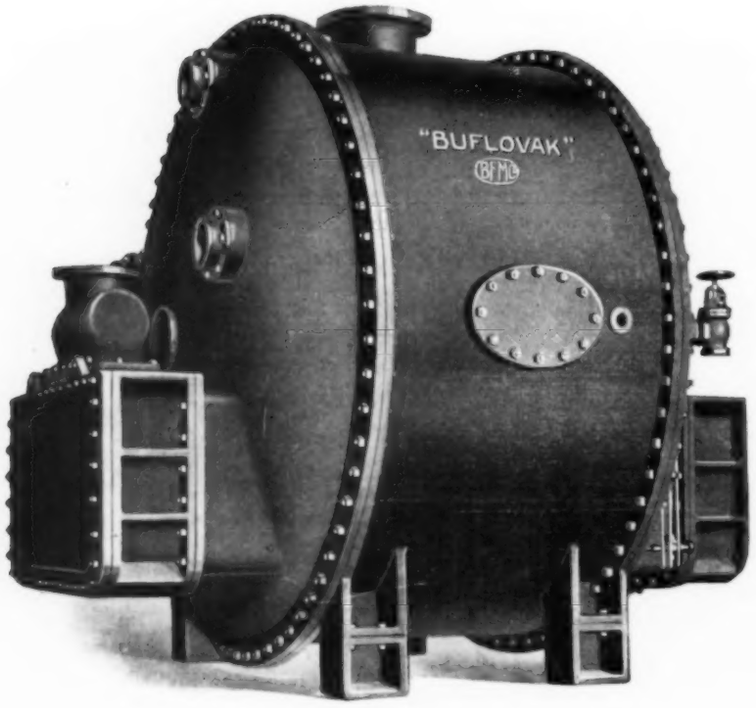


Fig. 1

the tubes at high speed, keeps them clean by the scouring action, and therefore eliminates the necessity of frequent cleaning.

Losses by entrainment are generally



Rear View

Horizontal Tube Evaporator—*Continued*

caused by excessive vapor speed, and this difficulty has been overcome by making the width of the evaporator body, above the liquor level, about twice the width of the tube nest. The importance of this extra width may readily be seen from the fact that the losses increase with the square of the speed, other conditions being equal.

The construction of the "Buflovak" evaporator will also greatly reduce losses caused by foaming, which is sometimes unavoidable in this type of evaporator. The best way to stop foaming is to lower the liquor level and reduce the quantity of liquor in the pan. The illustration shows quite clearly that the amount of liquor will diminish very quickly when the level is lowered.

Another very important feature of the "Buflovak" Type is the possibility of increasing the capacity of the evaporator by adding another belt to the present shell. Quite frequently it is found desirable to enlarge the plant after a short period of operation, and generally it means an entire new plant. Not so with the "Buflovak," where only the additional belts and new tubes have to be purchased.

The H. T. Evaporator is built in two standard sizes 96 in. and 114 in. diameter, and the length of the tubes being from 6 ft. to 16 ft. The range of heating surface is from 590 to 2460 sq.ft.; also special sizes down to 40 sq.ft. Apparatus can be built of cast iron, steel, copper, bronze, aluminum; also of cast iron or steel and lined with acid-proof material.

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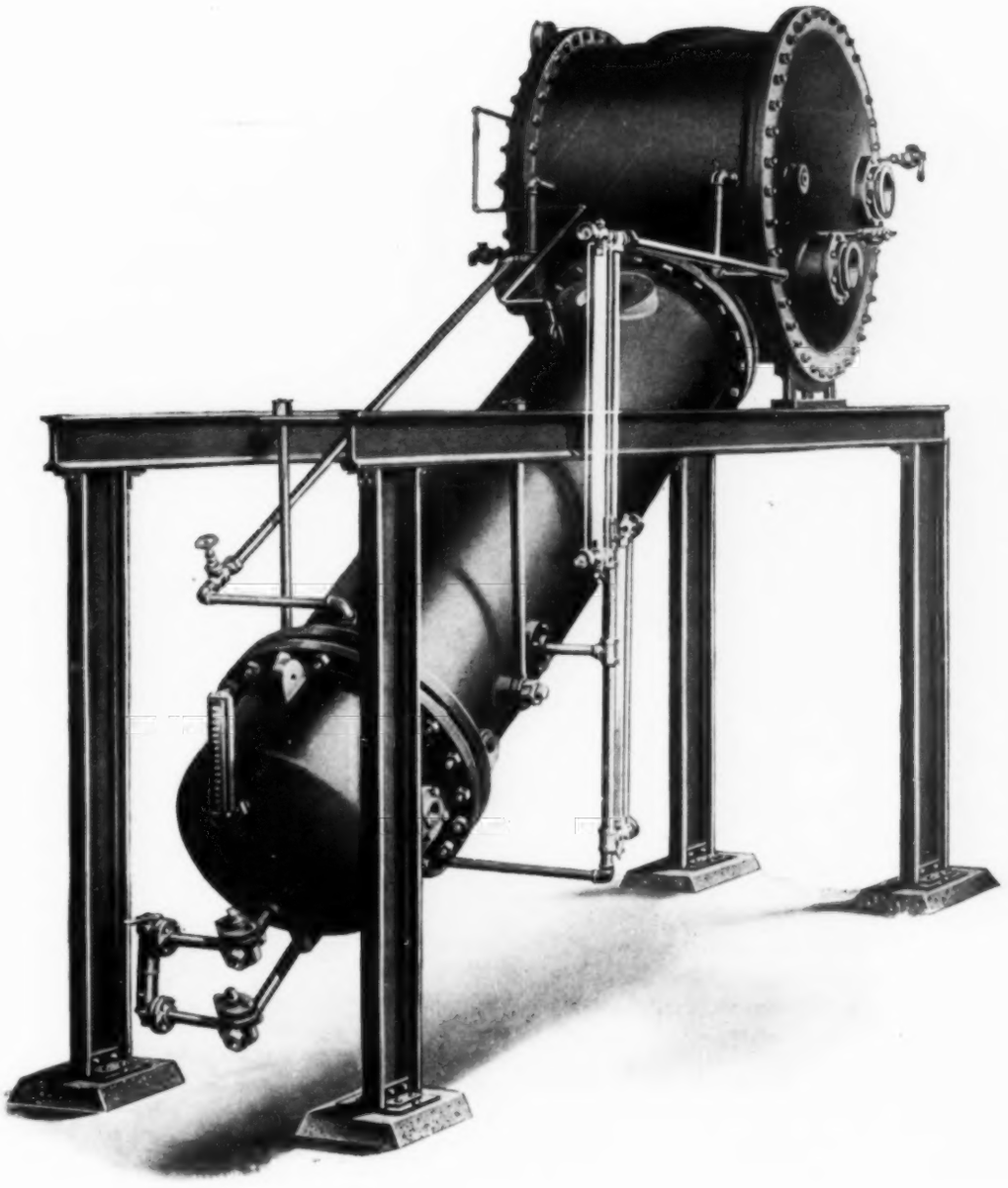

"Buflovak"
Rapid Circulation Evaporator

BUFFALO FOUNDRY AND MACHINE COMPANY

"Buflovak" Rapid Circulation Evaporator

Semi-Film

The inclined type has been developed from the standard return tubular boiler and adapted for the special purpose of handling foamy and delicate liquors.

The standard type is shown in Fig. 2, and consists of a horizontal cylindrical vapor body and, bolted to it, an inclined cylindrical steam-chest, the end of which is closed by suitable removable cover. The steam-chest is divided by a solid partition into two compartments. The upper large compartment is filled with tubes which are expanded in the flue-sheets, closing both ends. The lower and much smaller compartment, called the downtake, is open at both ends. The steam is around the tubes and the liquor inside the tubes; the vapor and a part of the liquor pass through the upper part of the tubes at a very high speed, and are thrown with great force against the ribs of the baffle plate which extend across the whole cylindrical length of the vapor body. The liquid returns through the downtake to the lower part of the steam-chest while the vapor passes at both ends of the partition plate into the vapor space and from there through the entrainment separator to the next effect or condenser. The amount of liquor in circulation is very small and the possibility of foaming is reduced to a minimum, as the liquor level is always kept rather low and the foam is broken up in the upper part of the tube where film evaporation takes place.

The high speed of the liquor in the tubes (100 feet per second or more) has a tendency to keep the heating surface clean; however, scale can be removed very quickly from the outside after the small cover at the end of the steam-chest has been taken off.

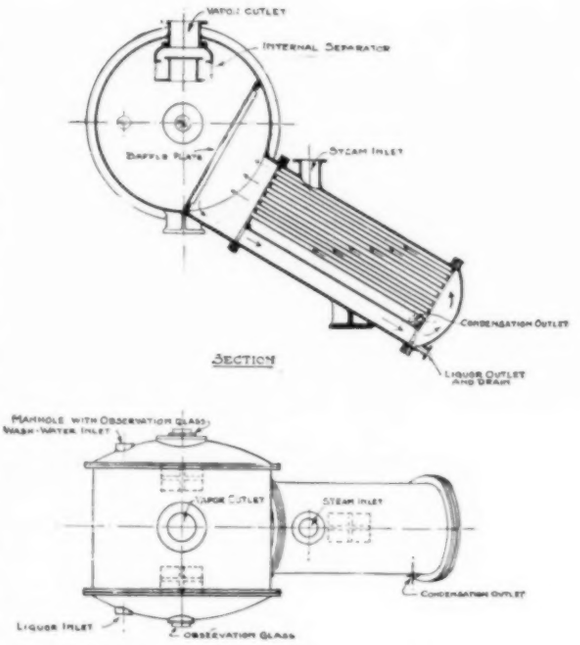

Fig. 2

The illustration shows the construction of the steam-chests with the large downtake for the return of the liquor; all castings are carefully inspected and tested before the steam-chests are assembled.

The inclined Rapid Circulation type is built in five standard sizes with different lengths of steam-chests and the heating surface varies from 130 to 1520 square feet.

In some cases where a rather large heating surface is required, two standard steam-chests are bolted to a single vapor body and the construction of this Duplex type is shown in Fig. 3.

Each steam-chest has separate connections for steam, condensation and liquor, but only one vapor outlet.

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Rapid Circulation Evaporator—*Continued*

Vapor Bodies for Rapid Circulation Evaporator

Steam Chests for Rapid Circulation Evaporator

BUFFALO FOUNDRY AND MACHINE COMPANY

Rapid Circulation Evaporator—*Continued*

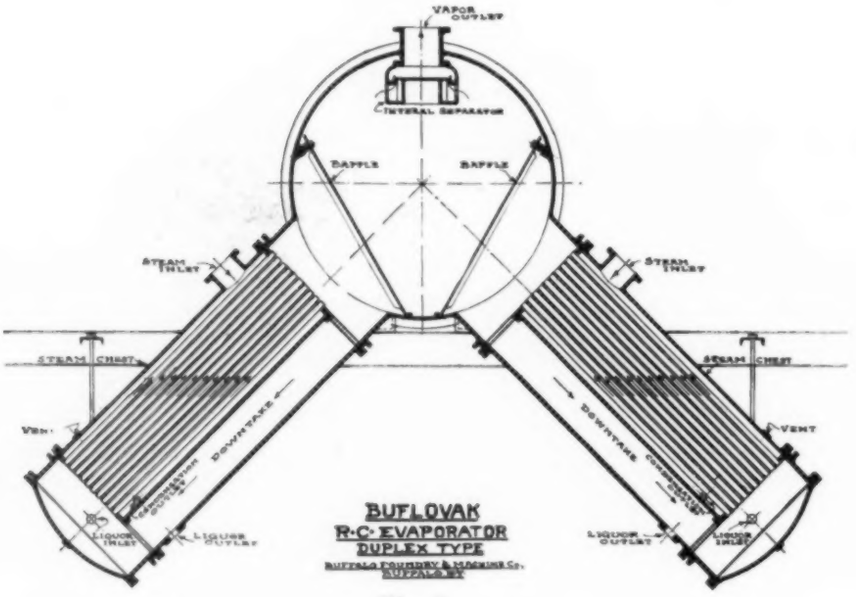
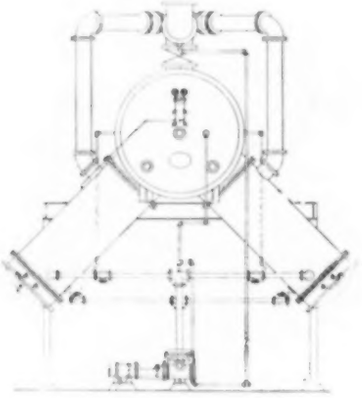
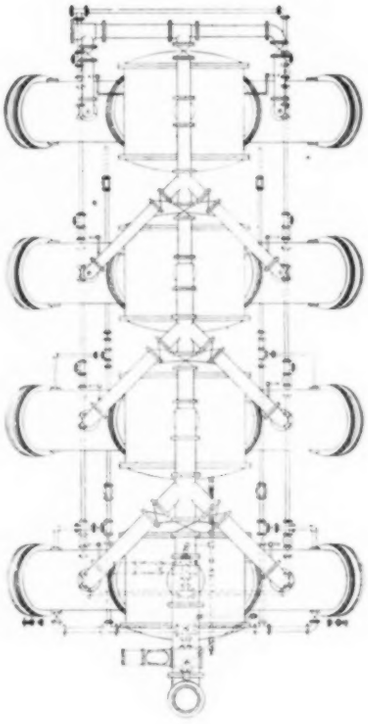


Fig. 3

Fig. 4 shows a Duplex Rapid Circulation Quadruple Effect Evaporator handling 9000 gallons of liquor per hour. All pipe lines for vapor, liquor and condensation are equipped with the necessary valves and fittings so that each effect can be cut off without interfering with the operation of the other evaporators.



Elevation

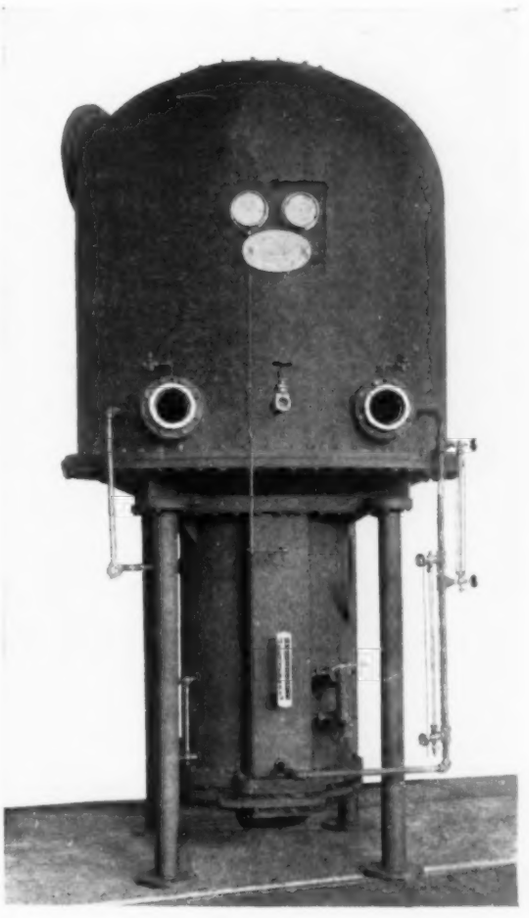


Plan

Fig. 4

Vertical Rapid Circulation Evaporator

A special type of Rapid Circulation Evaporator is shown in Fig. 5. This construction has been developed from the standard vertical tube evaporator, increasing the length of the tubes, and reducing the liquor space. Careful experiments, which have been confirmed by practical experience, have shown that the coefficient of heat transmission is highest when the liquor level in the tubes is about one-third of the tube length above the lower flue-plate. The upper part of the tube is covered with a climbing film of liquor, and this accounts for the large capacity of the heating surface. This type is especially suitable for the concentration of thin liquids of foamy nature, or organic solutions which should not be exposed to the heat any length of time. The vapor and liquor which have boiled up in the tubes are returned downwards by the baffle ring; the liquor goes back to the bottom of the steam-chest, while the vapor passes upwards through the large vapor space to the vapor outlet. Entrainment of liquor drops in the vapor is prevented by the change of direction and the reduction of vapor speed as soon as it leaves the baffle ring.



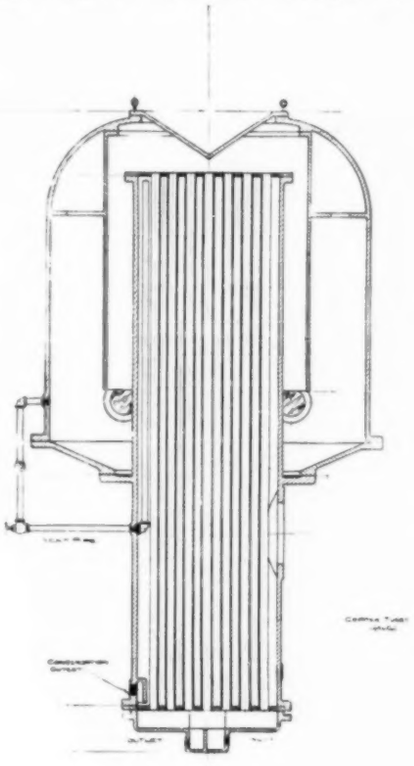


Fig. 5

The steam enters the steam-chest from the top through the vapor dome; condensation and non-condensable gases are removed through hollow lugs which at the same time are used as supports for the steamchest. Top and bottom of the evaporator can easily be removed. Density of the liquor is under perfect control, which is not the case with other evaporators of the climbing film type.

The Vertical Rapid Circulation Type is built in five standard sizes having from 350 to 1700 square feet heating surface. It occupies very little floor space and the erection and operation are extremely simple.

BUFFALO FOUNDRY AND MACHINE COMPANY

"Buflovak"
Vertical Tube Evaporator

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1543 FILLMORE AVENUE, BUFFALO, NEW YORK

"Buflovak"
Vertical Tube Evaporator

The Mantius Crystallizing Evaporator has been developed from the old standard evaporator constructed over seventy years ago by Mr. Fl. Robert. The most important change is in the steam-chest which formerly was an integral part of the evaporator body, but is now a separate unit allowing a better circulation of the steam and liquor. This type is used mainly for liquors with soluble salts which will precipitate during concentration.

The construction is shown in Fig. 6. The evaporator consists of the cylindrical shell with dished head and cone bottom, and the steam-chest of the floating type forming a separate unit; interior of chest is equipped with suitable baffles and channels for the efficient distribution of the steam and separation of non-condensable gases.

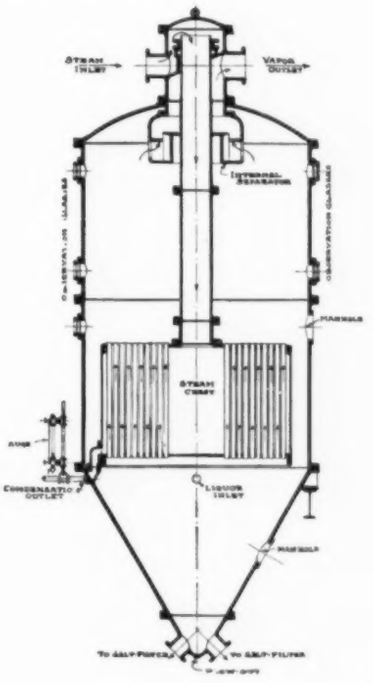


Fig. 6

The steam entering through the central inlet at the top is readily distributed over the whole heating surface, and the liquor boiling up in the tubes is thrown towards the outer shell where a large annular downtake is left for the return of the liquor to the lower part of the evaporator. The proportions are such that the speed in the tubes is very much higher than in the lower part of the downtake, allowing the salt to settle out before the liquor again reaches the heating surface. The condensed steam and non-condensable gases are removed from the steam-chest through hollow lugs which at the same time serve as supports.

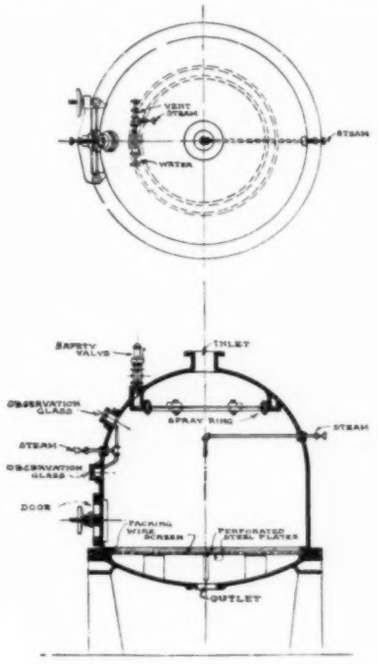


Fig. 7

The precipitated salt passes from the cone bottom into the salt filter, a cross section of which is shown in Fig. 7. As soon as the filter is filled with salt the mother liquor is drawn off and the salt washed with weak liquor, or hot or cold

Vertical Tube Evaporator—*Continued*

water. If the salt is to be recovered in solid form it is dried by hot air or superheated steam and then removed through the manhole; if the salt is to be used again in a solution it can be dissolved right in the salt filter and discharged by pumping. Where large quantities of salt are to be handled, two salt filters are connected to each evaporator and used alternately.

The Mantius Crystallizing Evaporator is built in twelve standard sizes with a heating surface of from 300 to 2440 square feet. The salt filters are manufactured in five sizes having a net capacity of from 300 pounds to 5000 pounds per charge.

Steam-Chest for Vertical Tube Evaporator

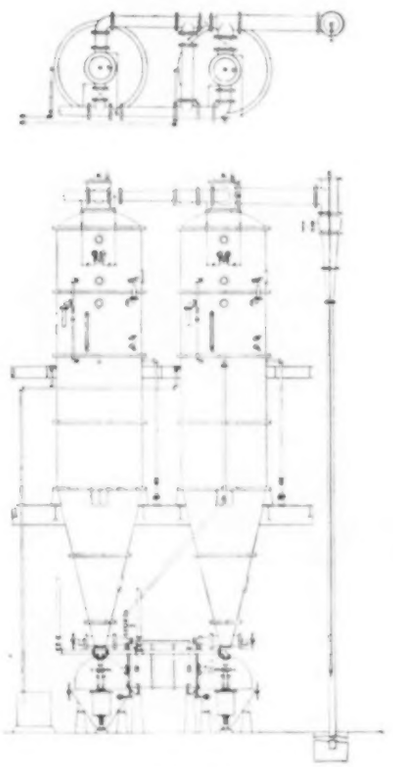


Fig. 8

A special type of crystallizing evaporator is shown in Fig. 8. The capacity as a double effect is 2500 gallons per hour, and the arrangement is such that the output can be doubled by operating both pans as single effects. The height of the evaporators, and therefore, the liquor levels, is such that the mixture of liquor and salt crystals is discharged by gravity against the vacuum into the receiver and from there into the rotary salt filters. The dry salt is scraped from the drum continuously while the mother liquor is returned to the feed tank. The finished liquor which has been freed from the salt in the settling space of the evaporator is discharged by gravity into a storage tank.

Vertical Tube Evaporator—*Continued*

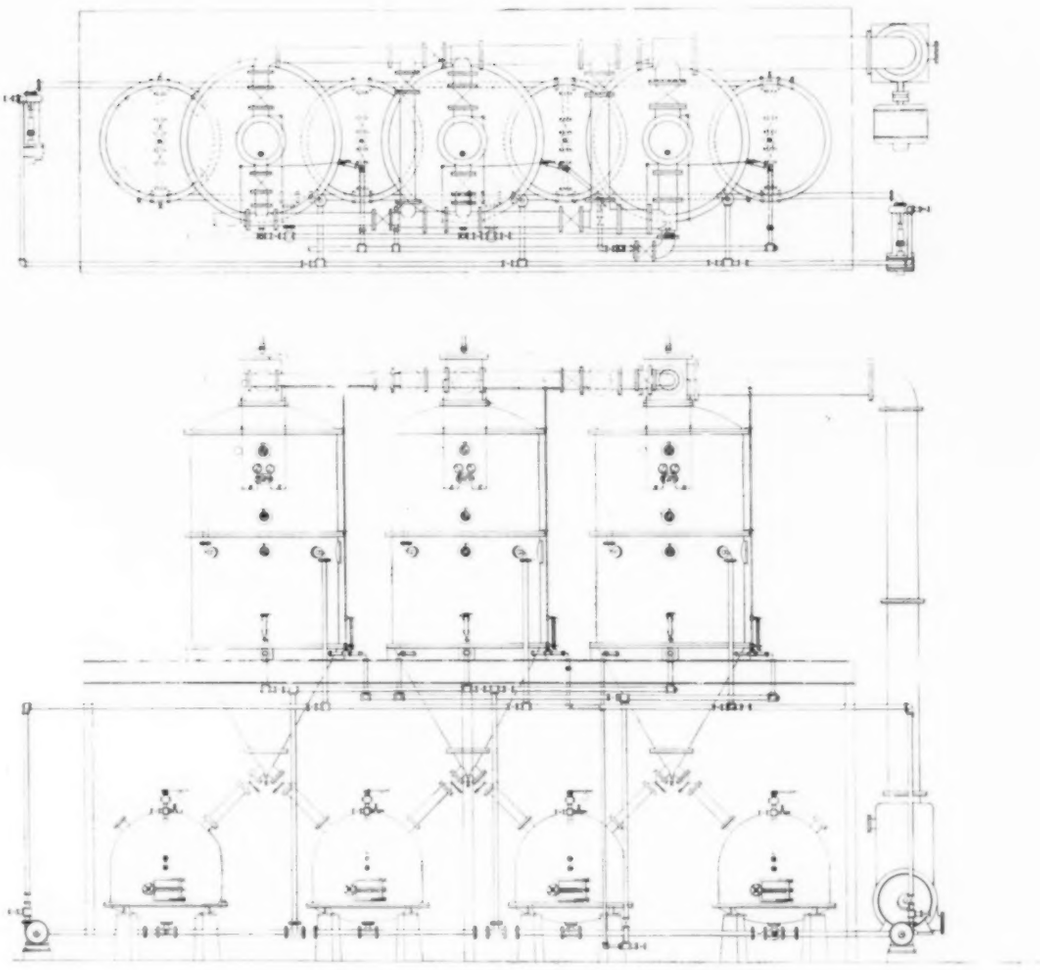


Fig. 9

Fig. 9 shows a triple effect evaporator with four salt filters for a capacity of 2400 gallons per hour. The salt-filter will take care of 60 tons of salt per day. The piping is arranged so that each evaporator can be cut off.

BUFFALO FOUNDRY AND MACHINE COMPANY

"Buflovak" High Concentrator

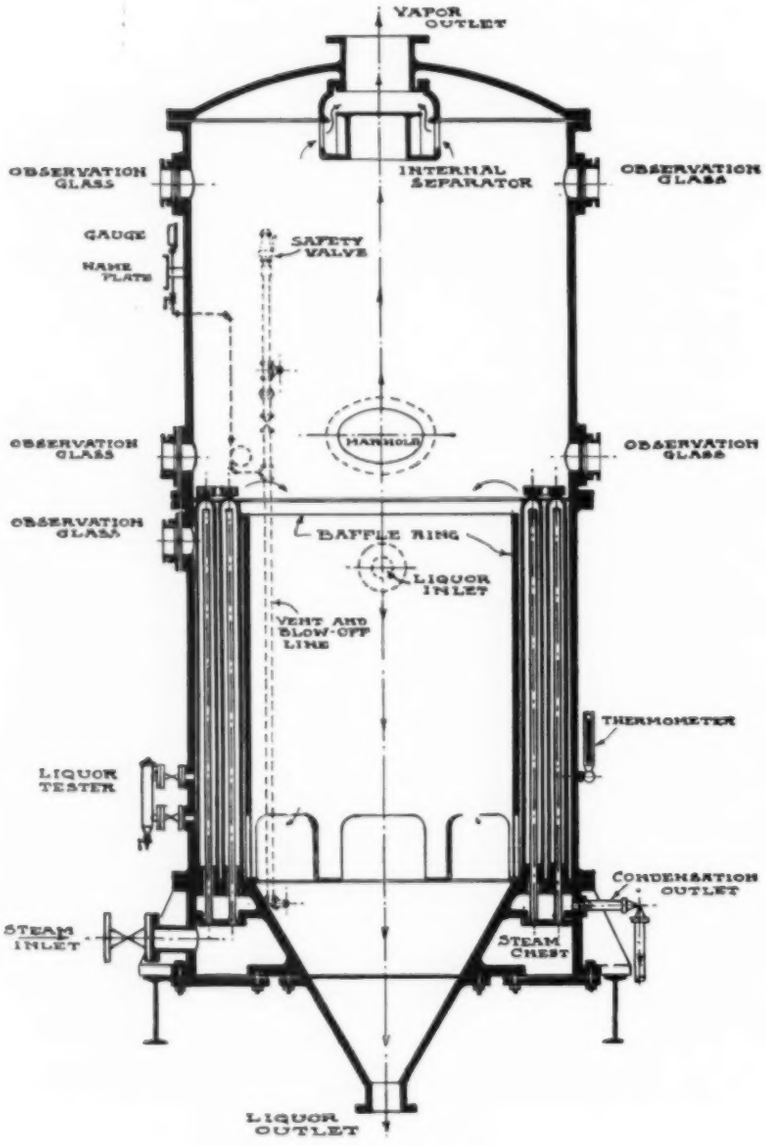


Fig. 10

1543 FILLMORE AVENUE, BUFFALO, NEW YORK

"Buflovak" High Concentrator

Used for the high concentration of Caustic Soda, Potash, Ammonium Nitrate, and Electrolytic Caustic Solutions above 36° Be.

This type is of special design which is protected by U. S. Letters Patent granted several years ago to Mr. O. Mantius, and now controlled by us.

The High Concentrator consists of vapor body, liquor body, steam-chest, and heating tubes. The construction is shown in Fig. 10. The vapor and liquor belt are of standard design, allowing ample vapor space above the heating surface, and equipped with manhole, observation glasses, liquor testor, guages and all standard fixtures. The steam-chest consists of a heavy cast iron flueplate and spherical cover built for a working pressure of 100 lbs. and divided by a cast iron diaphragm plate into an upper compartment for condensation and non-condensable gases, and a lower section for the high pressure steam. The heating surface is formed by a number of upright special cast iron tubes having an outside diameter of 4". These tubes are screwed into the flueplate by means of special double extra strong nipples and the machined surfaces of flueplate and tube end are protected from corrosion by special gaskets. This construction makes an absolutely tight joint and permits the replacing of defective tubes by ordinary labor. Vibration of the upper closed ends of the tubes is prevented by cast iron supports or spiders. Tubes are arranged in circular rows spaced together very closely with a large downtake in the center. This arrangement causes a very rapid uniform circulation of the liquor, and makes it possible to overcome the viscosity of heavy solutions and concentrate to high densities that are not obtainable in evaporators of standard construction.

The steam passes from the lower compartment of the steamchest to the top of the heating tube through small pipes

Tubes for High Concentrator

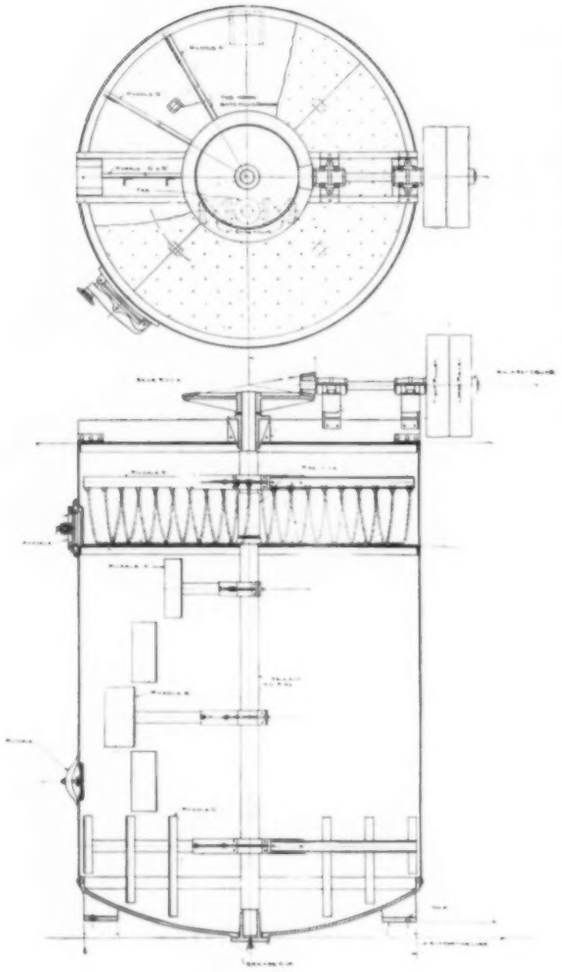
which are screwed tight into the diaphragm plate. These pipes have a smaller diameter than the inside opening of the special nipples, allowing the condensation and non-condensable gases to pass from each tube into the upper steamchest chamber and from there to the outside. The counter-current action between liquor and steam contributes to the high efficiency of this type of evaporator.

High Concentrators are furnished as Single or Multiple Effects, with or without salt separation; tubes can be made of special cast iron, copper, bronze or aluminum. Special care has been taken that the number of joints is reduced to a minimum and that all parts are readily accessible.

This type is built in six standard sizes, with different number and length of tubes so that the heating surface will vary from 110 to 1250 square feet per unit.

Caustic Plants

For the Manufacture or Recovery of Caustic Soda and Potash from Carbonates



Causticizer, open type

Complete Causticizing Equipment furnished for the manufacture of caustic soda and potash from carbonate, and also recovering caustic from waste carbonate or sulphite liquors by caustification. Continuous processes for large quantities or batch operation for small plants. Systematic washing of lime sludge.

Leaching Tanks: For carbonate soda and potash.

Lime Dissolvers

Causticizers: Closed or open construction, continuous or batch type.

Settling and Filter Tanks

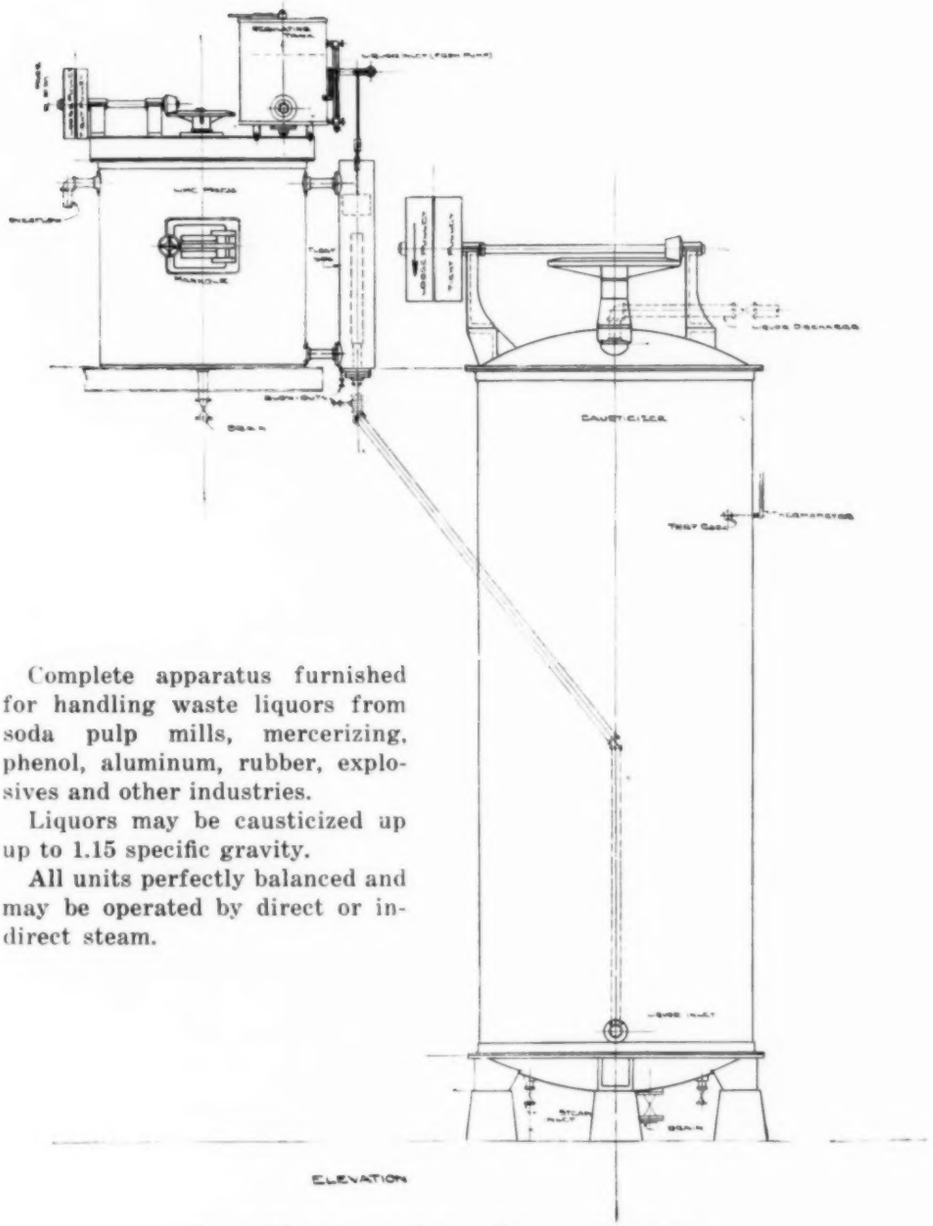
Evaporators: Horizontal, Rapid Circulation and Vertical type with and without separation of solids (See pages 45 to 59).

High Concentrators: For producing 80% caustic solutions (See page 60).

Caustic Pots (See page 76).

Flaking Machines: For producing flake caustic soda.

Caustic Plants—*Continued*



Complete apparatus furnished for handling waste liquors from soda pulp mills, mercerizing, phenol, aluminum, rubber, explosives and other industries.

Liquors may be causticized up up to 1.15 specific gravity.

All units perfectly balanced and may be operated by direct or indirect steam.

Lime Dissolver and Causticizer, Closed Type

"Buflovak" Evaporator Accessories

Unless otherwise specified, "Buflovak" Evaporators are furnished with complete condensing systems, pipe lines, valves, fittings and pumps. It is the general practice to use wet system condensers with wet vacuum pumps for small installations and barometric condensers with dry vacuum pumps for large plants. Evaporators are equipped with entrainment separators, manholes, hand-holes, electric light openings, observation glasses, gauges for steam, liquor and water, liquor testers, thermometers and vacuum breakers; also automatic liquor level controllers for large installations.

Evaporating Problems

Data Required

To facilitate correspondence regarding evaporating problems it is desirable to have full information when such problems are submitted, especially the following:

1. Description of material to be evaporated.
2. Quantity to be treated per hour.
3. Density and percentage of solids in thin liquor.
4. Density and percentage of solids in heavy liquor.
5. Temperature of thin liquor.
6. Boiling points of thin and heavy liquor.
7. If liquor is complex in nature, give analysis and other details such as foaming, scaling, corrosiveness, etc.
8. Amount of solids to be separated.
9. Degree of dryness required and purity desired.
10. Live steam pressure available.
11. Exhaust steam pressure and quantity available.
12. Cooling water available; quantity and temperature.
13. Location of proposed plant.

Testing Laboratory

Evaporating tests can be conducted in our Research Laboratories without charge or obligation, provided materials are furnished and transportation charges paid.

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"Buflokast"
Chemical Apparatus

Nitrators	Fusion Kettles
Reducers	Phenol Stills
Reflux Condensers	Beta Naphthol Stills
Sulphonators	Vacuum Ovens
Vacuum Stills	Nitric Retorts
Drum Dryers	Denitrators
Autoclaves	Acid Eggs
Caustic Pots	Crystallizers
Caustic Flakers	Jacketed Kettles

Nitric Acid Plants

Concentrating Apparatus for Nitric, Sulphuric and Hydrochloric Acids

Recovery Systems for Nitric and Sulphuric Acids

Acid-Resistant Castings

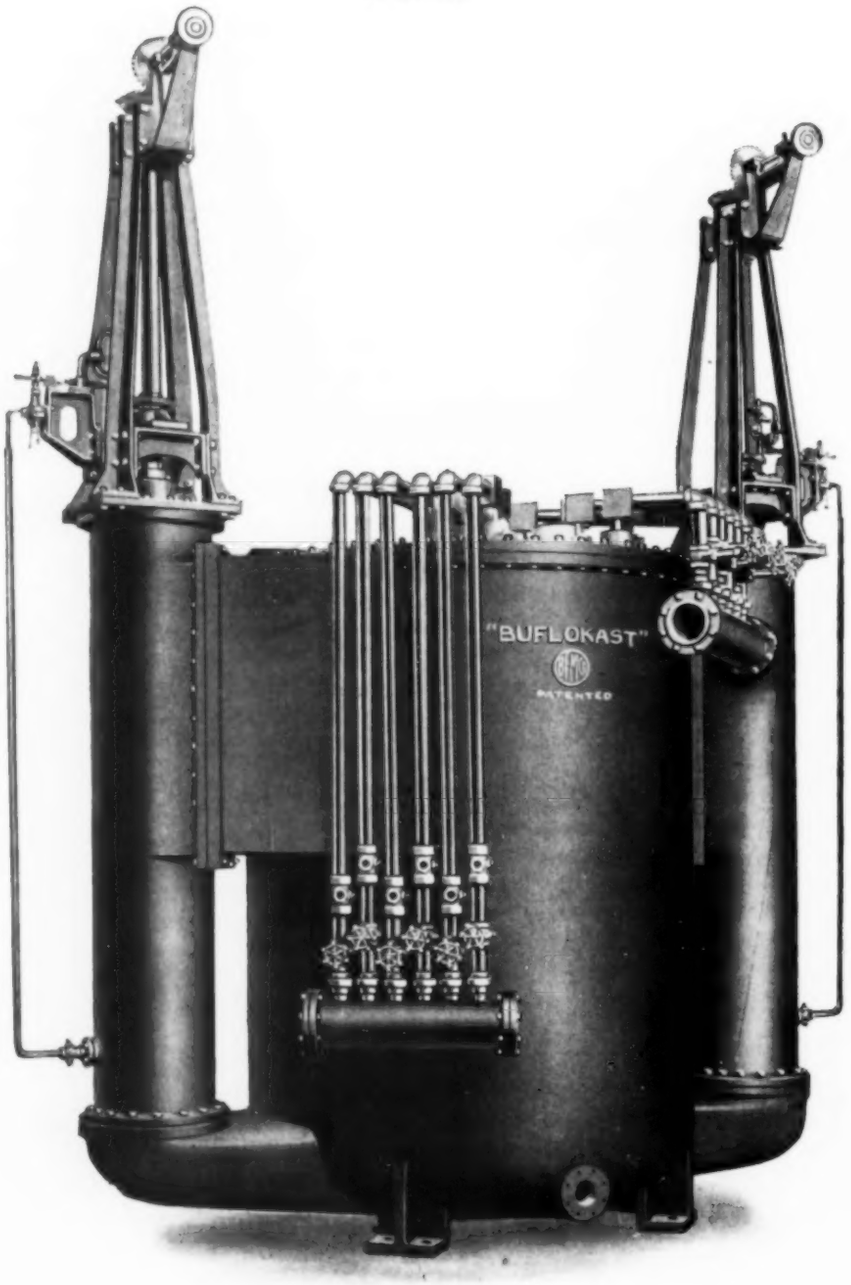
Special Chemical Castings

BUFFALO FOUNDRY AND MACHINE COMPANY

"Buflokast" Nitrator

Hough Type

(Patented)



1543 FILLMORE AVENUE, BUFFALO, NEW YORK

"Buflokast" Nitrator

Hough Type

(*Patented*)

This apparatus was designed in response to the demand for a nitrator combining in a self-contained, compact unit all the elements required to insure high efficiency, safety in operation and large output. It is used in the manufacture of Trinitrotoluol (TNT), Dinitrobenzol and Mononitrobenzol. It can be used for nitrating, reducing, sulphonating, chlorinating, and other purposes in the chemical industry. Some of the notable features are as follows:—

In the No. 4 size, which is 6′ 6″ diameter by 9′ deep, the circulation of acids through the entire nitrator is at the rate of 5000 gallons per minute, which is equivalent to a displacement of the entire contents TWICE EVERY MINUTE.

The supply of hydrocarbon undergoing nitration is almost perfectly and automatically controlled. In the event of the agitators becoming inactive on account of the power being shut off or from any other cause, the governors automatically close the supply when half the normal speed is reached.

A predetermined temperature is maintained at all points of the nitrator during nitration, thereby insuring high capacity and a maximum degree of safety in operation.

By no possibility can water from the cooling coils pass into the machine in the event of a coil becoming defective, as a faulty cooling coil is at once made apparent to the operator by the indicator attached to the coil terminal.

Maximum cooling effect is obtained by a combined vertical circulation and rotary movement of the acids in the machine.

The circulation of acid is such that at the point of contact of the hydrocarbon and the acid there is no appreciable local rise in temperature. (In nitrating toluol to TNT direct, the ratio of acids to toluol at the point of contact is 3600 to 1.)

The nitrator is very flexible. TNT and Dinitrobenzol can be made by a one-step process. Mononitrobenzol and Mononitrotoluol are prepared with practically no side reactions and therefore no decomposition and waste.

This apparatus has a capacity for output far in excess of any other type ever placed on the market, and reduces to a minimum the amount of operating labor required.

The design and principle of the apparatus is such that it is possible and feasible to reproduce on a commercial manufacturing scale the conditions obtaining in the laboratory where the research chemist has determined by experiments the conditions necessary to obtain the highest yield and best results, and consequently greatest economy in the use of raw materials.

The two principal factors to be considered in conducting chemical reactions are 1st—control of temperature; and 2nd—agitation of the reacting chemical compounds. Whether the process is one of nitration, sulphonation or reduction, the one great underlying principle is the same, viz: control of temperature at the *point of reaction.* Some reactions are sluggish at the temperatures considered safe in the older types of apparatus, and any elevation towards that point where the reaction becomes rapid may result in a sudden rise beyond the instant control of the old type nitrator. On this account the slower and necessarily more costly methods of nitration and reduction were necessary before the advent of the Hough type.

Many reactions have to be run at temperatures varying only a few degrees, if good results are expected. With the old type apparatus this required the greatest skill and attention on the part of the operator.

Can be Used for Nitration, Reduction and Sulphonation

Any one of these processes may be carried on with equal efficiency in the Hough Nitrator, and very rapidly under ideal con-

"Buflokast" Nitrator Hough Type—*Continued*

ditions, as *the temperature of the solution even at the point of contact can be controlled and held within a fraction of a degree.* This ideal operating condition enables the factory operator to duplicate the conditions under which laboratory experiments are conducted, thereby producing results heretofore unequalled if not considered impossible.

When used as a nitrator handling Glycerine, Glycol, or any similar compounds, it is impossible to over-estimate the value of the automatic devices which instantly cut off the supply of liquid being nitrated should the speed of the agitators for any reason fall beyond a certain point. The use of these safety devices in the process of nitration provides a degree of safety in operation far greater than is possible when wholly dependent on the attention of the operator.

When used as a reducer it is possible to conduct a reducing reaction (such as the reduction of Meta-Dinitrobenzol to Meta-Nitraniline) with such perfect uniformity without the least danger of over-reduction, that much higher yields are obtainable than have been considered practicable heretofore.

The sulphonation of benzol, naphthalene, and phenol can be conducted in the Hough Nitrator with more favorable results than is possible in any other type; both as to quality of product and the time required in the process. For instance, the sulphonation of Beta Naphthol requires that the temperature be maintained between narrow limits to obtain satisfactory results. Likewise, in the nitration of Naphthalene-Tri-Sulphonic Acid, which requires that the temperature be maintained between 23° C. and 25° C. to obtain the best results. With apparatus of the old type these conditions could not be maintained without rendering the processes impractical in point of time required for the operation. With the Hough Nitrator, on the other hand, these conditions can be easily obtained and the processes conducted in the most rapid manner.

The following are some of the compounds in the manufacture of which the Hough Nitrator can be employed to great advantage:

AS A NITRATOR

Mononitrobenzol
Dinitrobenzol
Dinitrochlorbenzol
Nitro-Zylol
Mononitrotoluol
Dinitrotoluol
Trinitrotoluol
Dinitronaphthalene
Trinitronaphthalene
Tetranitronaphthalene
Trinitroglycerine
Ethylene Glycol Dinitrate
Propolene Glycol Dinitrate
Amido-Naphthol Di-Sulphonic Acid H

AS A SULPHONATOR

B-Naphthol-6-Sulphonic Acid
B-Naphthol-3: 6 Disulphonic Acid
Naphthalene Trisulphonic Acid
Beta-Naphthylamine Disulphonic Acid G
Anthraquinone Sulphonic Acid
Benzene Sulphonic Acid

AS A REDUCER

Meta-Nitraniline, etc.

AS A CHLORINATOR

Chlor Benzol, etc.

STANDARD SIZES

No.	Inside Diameter	Inside Depth
1	21"	27"
2	3' 9"	5' 2"
3	4' 6"	6' 0"
4	6' 6"	9' 0"

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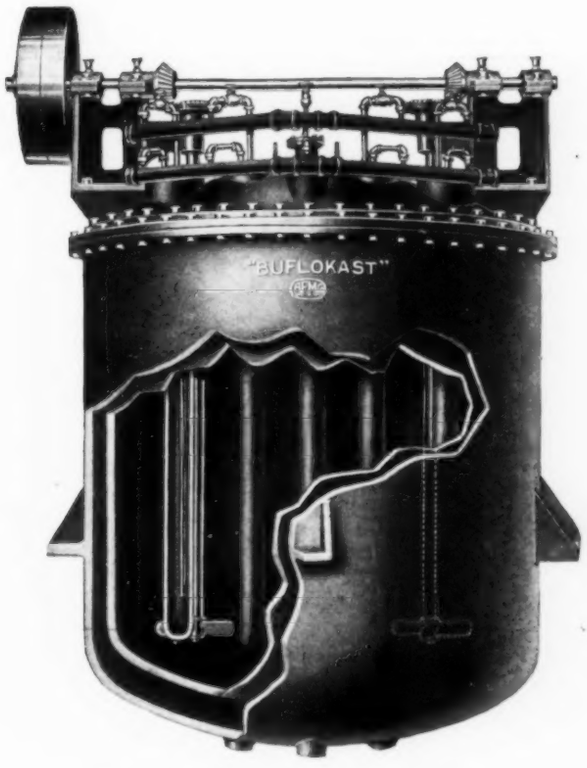


"Buflokast" Nitrator

The "Buflokast" Nitrator consists of a cast-iron body surrounded on the sides and bottom with a cooling jacket, which is furnished tight or loose depending on whether or not a pressure is to be used in the jacket. The jacket can be made of cast-iron or steel plate. Two agitator shafts located at opposite sides, or one shaft, located centrally, are provided. The use of two agitators is a special feature of the "Buflokast" Nitrator which assures constant agitation even though one agitator should become inactive for any cause.

Used in Manufacturing

Nitrobenzol
Nitrotoluol
Aniline
Toluidine
Xylidine
Dinitrobenzol
Dinitrotoluol
Meta-Nitraniline
Meta-Phenylenediamine
Meta-Toluylenediamine
Nitrochlorbenzol
Dinitrochlorbenzol
Para-Amidophenol
Dinitrophenol
Para-Nitraniline
Para-Phenylenediamine
Alpha-Naphthylamine
Alpha-Naphthylamine Sulfonic Acids
Amido-Naphthol-Sulfonic Acids
H-Acid, Etc., etc.

The larger sizes also contain a series of Nitrator, which assures provide exceptionally quick cooling facilities in the center as well as along the sides of the interior. Water is forced to the bottom of the tubes, which are individually controlled. The temperature of the overflow from each tube can be noted and is regulated by a valve. The use of these tubes is made possible by our patented method of casting the tubes without chaplets, thus insuring freedom from leaks. This is the only successful method so far devised for manufacturing these tubes.

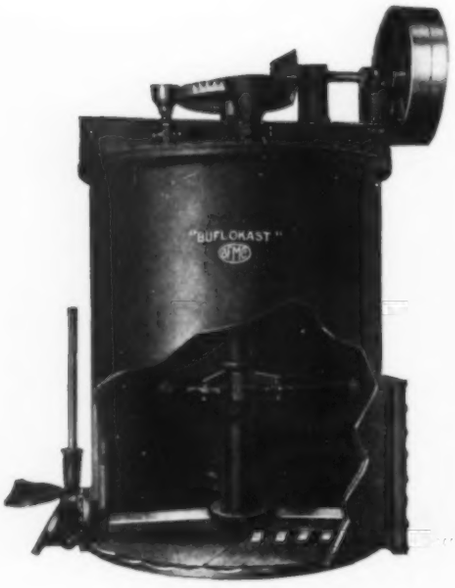
Another special feature is the arrangement by which the acid is charged below the level of the liquid or near the bottom where the most agitation takes place.

The apparatus is substantially constructed throughout. The special quality of metal used in the nitrator body, cast iron shaft and closed end tubes is the result of our long experience in furnishing castings for chemical work.

Standard Sizes

"Buflokast" Nitrators are furnished in standard sizes with holding capacities in gallons as follows: 1600; 800; 400; 200; 100; 50; and 8. Special sizes, or nitrators requiring other special features, are built to order.

BUFFALO FOUNDRY AND MACHINE COMPANY



"Buflokast" Reducer

Especially noted for its large output, ease and cleanliness of operation. Carefully constructed to meet the working conditions for which it is designed. The apparatus consists of a specially constructed cast iron body. The bottom and lower portion of sides are lined with special quality liner plates which are readily removable and can be renewed as occasion requires. The side plates are reversible, so that the upper portion of the plate can be used when the bottom part has become worn.

The shaft and agitator are suspended from a bearing in the top of the reducer and is also supported by a heavy bearing in the yoke midway in the reducer, as illustrated, thus eliminating the objectionable bottom or step bearing. A special feature of both shaft and agitator is that they are hollow, the steam being introduced through the shaft at the top and distributed in the reducer by means of outlets in the agitator. The agitator is of the tooth type, which insures better agitation and requires less power to operate than the plow type, so commonly used.

A large door on the side facilitates the removal and renewal of the liner plates when required, this door being fully protected by the lining. The materials and workmanship are first-class throughout, the cast iron being of a special quality as used in apparatus of this character.

Other features are the improved unloading device which automatically raises the valve when opened, and wedges it in position when closed; semi-steel cut gears, large factor of safety, etc.

Where a reducer with higher heating facilities is desired, we furnish the jacketed type, which is illustrated above.

Used in Manufacturing

Aniline
Toluidine
Xylidine
Benzidine
Tolidine
Meta-Nitraniline
Meta-Phenylenediamine
Meta-Toluylenediamine
Metanilic Acid
Para-Amidophenol
Para-Phenylenediamine
Alpha-Naphthylamine
Alpha-Naphthylamine-Amido-Naphthol-Sulfonic Acids
H-Acid
Etc., etc.

Standard Sizes

"Buflokast" Reducers are furnished in standard sizes with holding capacities in gallons as follows: 1600; 800; 400; 200; 100; 50; and 8. Special sizes, or reducers requiring other special features, are built to order.

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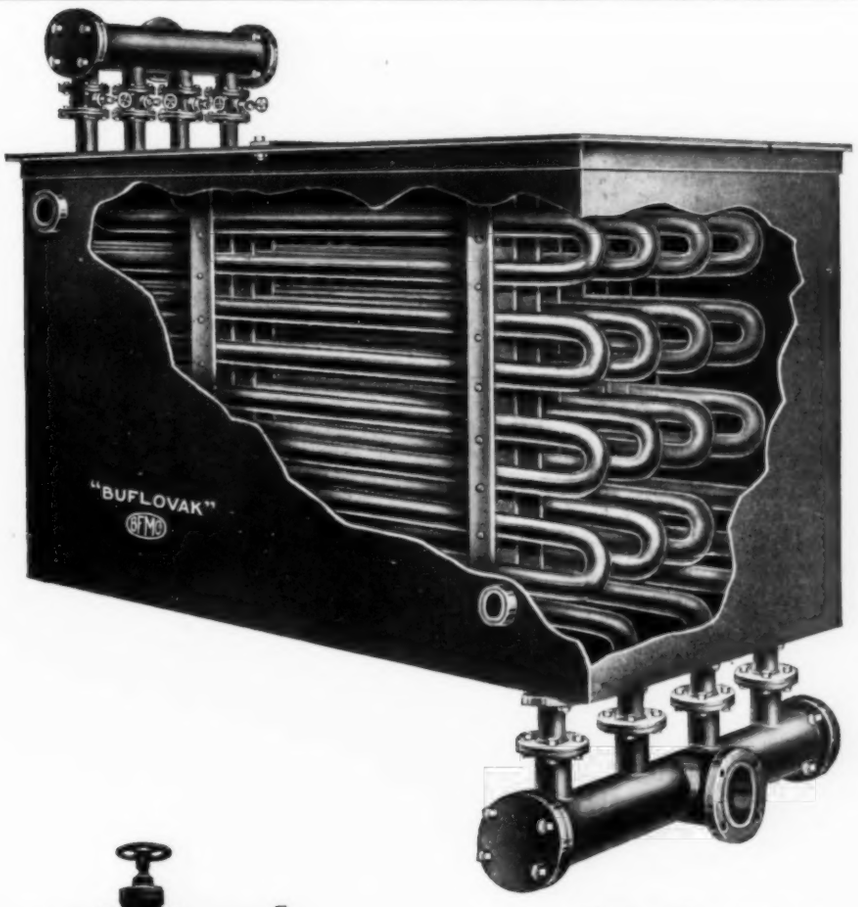

"Buflovak" Reflux Condensers

"Buflovak" reflux condensers are built in two types. One is rectangular in form with four zig-zag coils of wrought iron pipe. All coils are connected by manifold, with this great advantage—that each coil can be regulated independently of every other.

The other type condenser is circular in form, and being of more simple construction is less expensive than the rectangular type. It is in extensive use and gives efficient service.

Standard Sizes

	Square Feet Cooling Surface	Dimensions of Condenser Tank	
Rect. Type	105	72″ x 40″ x 54″	
	250	94″ x 58″ x 68″	
Circular Type		Diameter	Depth
	5	18″	18″
	16	24″	30″
	33	34″	42″
	56	50″	60″
	95	52″	50″

BUFFALO FOUNDRY AND MACHINE COMPANY

"Buflokast" Sulphonator

Noted for its efficiency and durability. Efficient agitation is provided by means of propellers attached to a shaft extending through a stuffing box in the cover. A feature of the "Buflokast" Sulphonator is the position of the propeller, which is placed at one side of the apparatus in order to produce a more effective agitation than is possible when the propeller shaft is located centrally. The sides and bottom of the kettle are steam-jacketed. On account of the action of the acids commonly treated in the apparatus, a special quality of metal is used in its construction. As will be seen, the design of the "Buflokast" Sulphonator is especially heavy and durable. Lugs are provided for supporting the apparatus.

The "Buflokast" Sulphonator is built in standard sizes with holding capacities in gallons as follows: 2600, 1800, 1200, 600, 400, 200, 150, 100, 50, 38, 8; other sizes built to order.

Used in Manufacturing

Metanilic Acid
Carbolic Acid
Picric Acid
Resorcine
Beta-Naphthol
Gamma-Acid
H-Acid
Beta-Naphthol-sulfonic acids
Naphthalene-sulfonic acids
Amido-Naphthol-sulfonic acids

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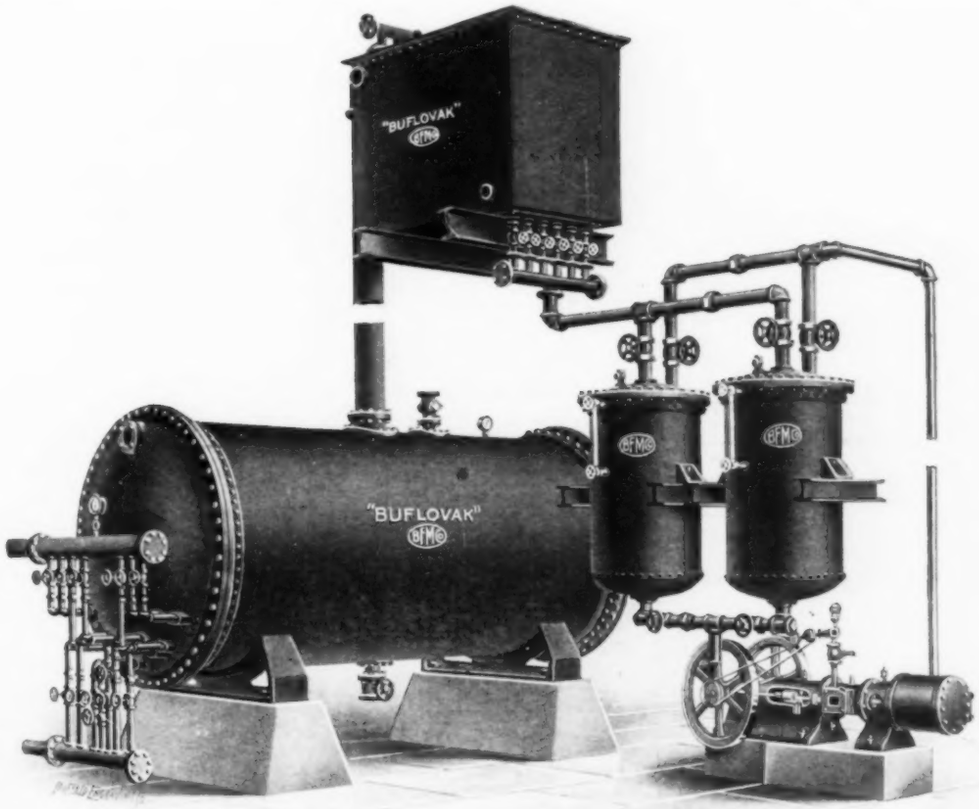
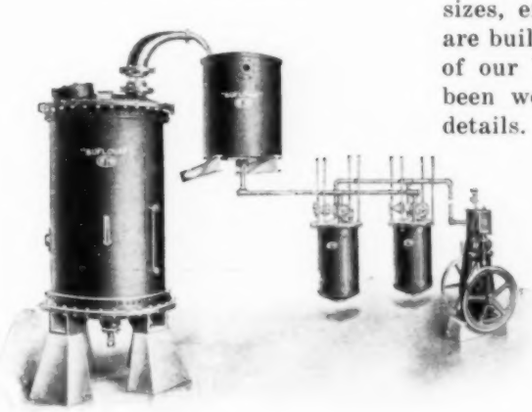


"Buflovak" Vacuum Still

Constructed of heavy steel plate and provided with heating coils in the bottom of the still. A goose-neck and vapor pipe extends from the top to a condenser of ample capacity. The still is also provided with two receivers and a vacuum pump.

These vacuum stills—furnished in various sizes, either the horizontal or vertical type—are built in accordance with the high standards of our Vacuum Apparatus. Their design has been worked out with exceptional care as to details.



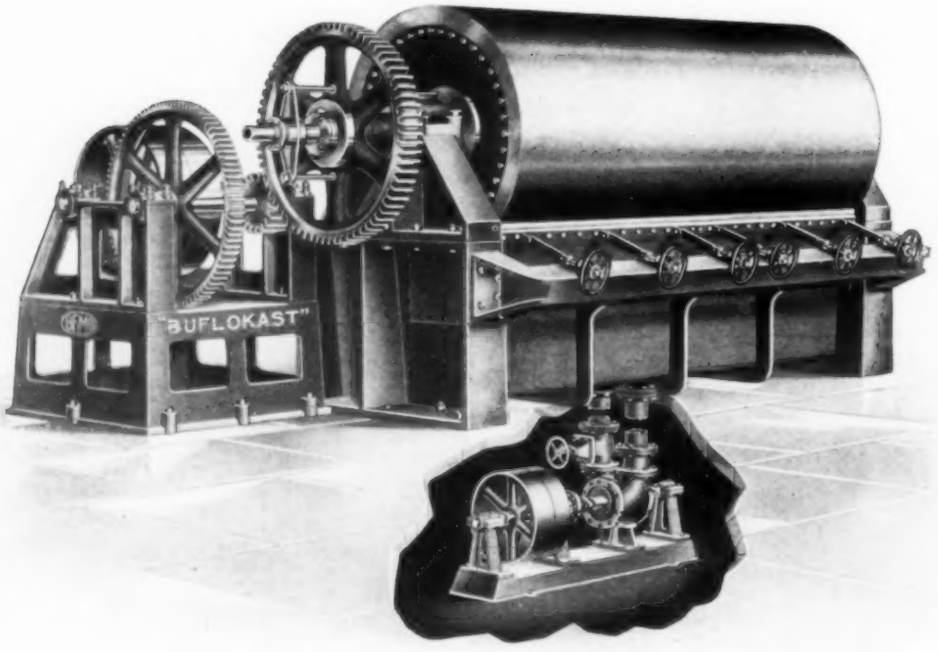
Sizes

	Holding Capacity Gallons	Diam. Inside	Depth or Length Inside
Vertical	33	1'-6"	2'-6"
	317	3'-0"	6'-0"
	752	4'-0"	8'-0"
Horizontal	1260	6'-0"	6'-0"
	2640	7'-6"	8'-0"
	5280	7'-6"	16'-0"

Used in Manufacturing

Aniline
Toluidine
Xylidine
Ortho-toluidine
Para-toluidine
Benzaldehyde
Etc., etc.

BUFFALO FOUNDRY AND MACHINE COMPANY



"Buflokast" Atmospheric Drum Dryer

Our laboratories have worked out new methods and apparatus for manufacturing various materials—the "Buflokast" Atmospheric Drum Dryer being but one example of the equipment thus produced.

The patented, successful principles of operation in this dryer are the cause of its exceptional success. It embodies the principles of the famous "Buflovak" Vacuum Drum Dryer. It is used for drying many liquid materials which do not require a vacuum, such as sodium benzol sulphonate, sodium acetate, sodium naphthalene sulphonate, etc.

This dryer consists of a hollow cylindrical drum supported over a cast iron storage tank. This drum is made of a special quality of cast iron, and has a smooth polished surface. The stream is introduced through the bearing at one end and the condensed steam or water is drained off through the opposite end.

The storage or reserve tank is made in one piece, thus eliminating joints in the tank and removing all danger of leakage through parts becoming loose or disconnected.

Our patented automatic device for applying the liquid to the drum produces a uniform coating on the drum and consequently a uniform dry product. The arrangement is such that only a small part of the drum surface is in contact with the wet material, leaving a greater working area for the drying of the material and thus producing a maximum output at a minimum cost for steam, power and labor. The scraper or knife is adjusted to the drum by a special device—controlled by a series of handwheels—which permit the most accurate and delicate adjustment.

Standard Sizes

No.	Diameter of Drum	Length of Drum
1	24"	20"
2	48"	20"
3	48"	40"
4	60"	72"
5	60"	144"

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"Buflokast" Autoclaves

"Buflokast" Autoclaves have been designed with a view to providing a rigid construction with a large factor of safety, so as to insure a high degree of safety in operation, and should not be confused with ordinary cheap autoclaves.

They are constructed of cast steel, bronze or cast iron depending on the pressure desired and the nature of the material to be treated. When necessary a special inner lining of "Buflokast" acid-resisting iron is provided as shown above.

Built in many commercial and laboratory sizes. Special sizes and designs built to order.

Electric Heating

"Buflokast" Autoclaves can also be arranged for being heated electrically. See page 19.

Standard sizes with holding capacities in gallons as follows: ¼, ½, 1, 2, 5, 10, 25, 50, 75, 100, 150, 200.

Used in Manufacturing

Dimethylaniline
Para Amidophenol
Anisidine
Phenetidine
Phenacetine
Alpha-Naphthol
Amido-Naphthol-Sulfonic Acids
H-Acid
Gamma Acid
Beta-Naphthylamine and its sulfonic acids
Etc., etc.

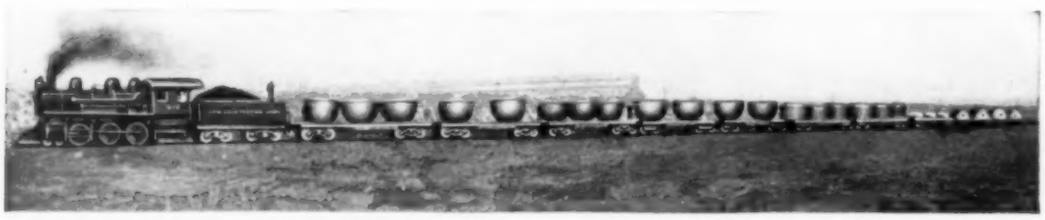
BUFFALO FOUNDRY AND MACHINE COMPANY

"Buflokast" Caustic Pots

These pots are so widely known throughout the chemical industry that a brief reference to them will suffice here. With very few exceptions all the caustic pots now used are "Buflokast." The success of these pots is clearly indicated by reports from our customers showing that they give from three to five times more service than those purchased elsewhere, either in this country or abroad. "Buflokast" Pots are built in varying sizes up to the capacity of the railroad companies to handle them, some of the most popular sizes having holding capacities of 2000, 2500 and 3200 gallons.

Caustic Flaking Apparatus

The demand for flaked caustic soda continues to grow. We are prepared to furnish apparatus for this purpose, having made a number of successful installations. Full information on request.



A Single Shipment of Caustic Pots

1543 FILLMORE AVENUE, BUFFALO, NEW YORK

"Buflokast" Fusion Kettles

Years of experience in manufacturing caustic pots enabled us to design and produce fusion kettles of equal efficiency in withstanding the combined action of the caustic and heat to which they are customarily subjected.

The agitator and shaft are made of the same metal as the kettle and are cast together in one piece, thus eliminating bolts which give considerable trouble by becoming loose and being eaten away by the caustic. The agitator, which is a special improved type, is suspended from a heavy bridge at the top which also supports the driving mechanism. The vertical shaft operates in a removable seat, which can be renewed when worn, as occasion requires.

Used in Manufacturing
Carbolic Acid
Beta-Naphthol
Resorcine
Nigrosine
Etc. etc.

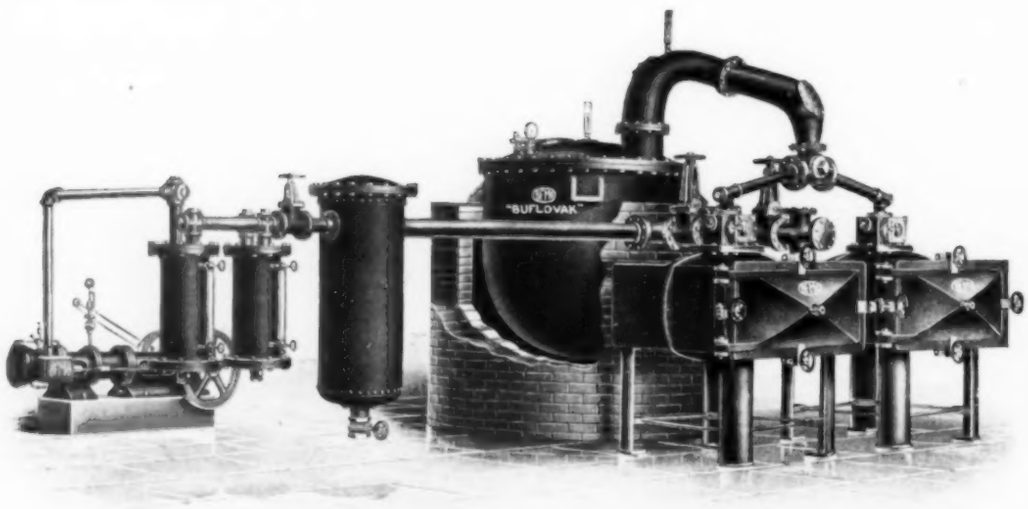
The "Buflokast" Fusion Kettle can be furnished with a draw-off spout at the bottom when this is desired.

Standard sizes with holding capacities in gallons as follows: 30, 50, 100, 200, 400, 600, 1000, 1500.

Electric Heating

These kettles can also be arranged for being heated electrically. See Page 19.

BUFFALO FOUNDRY AND MACHINE COMPANY



"Buflovak" Beta Naphthol Still

The illustration shows the general arrangement of a "Buflovak" Beta Naphthol Still with condenser, receivers, separators, vacuum pumps, etc. Judging by reports from users, it is doubtless the most successful still for the purpose now in use. It overcomes the difficulties encountered in Beta Naphthol distillation, especially in subliming, and vapors are prevented from passing to the vacuum pump. Standard sizes with holding capacities in gallons as follows: 50, 100, 200, 600.

Used in Manufacturing

Para-Phenylenediamine
Diphenylamine
Alpha-Naphthylamine
Beta-Naphthylamine
Alpha-Naphthol
Beta-Naphthol
Etc., etc.

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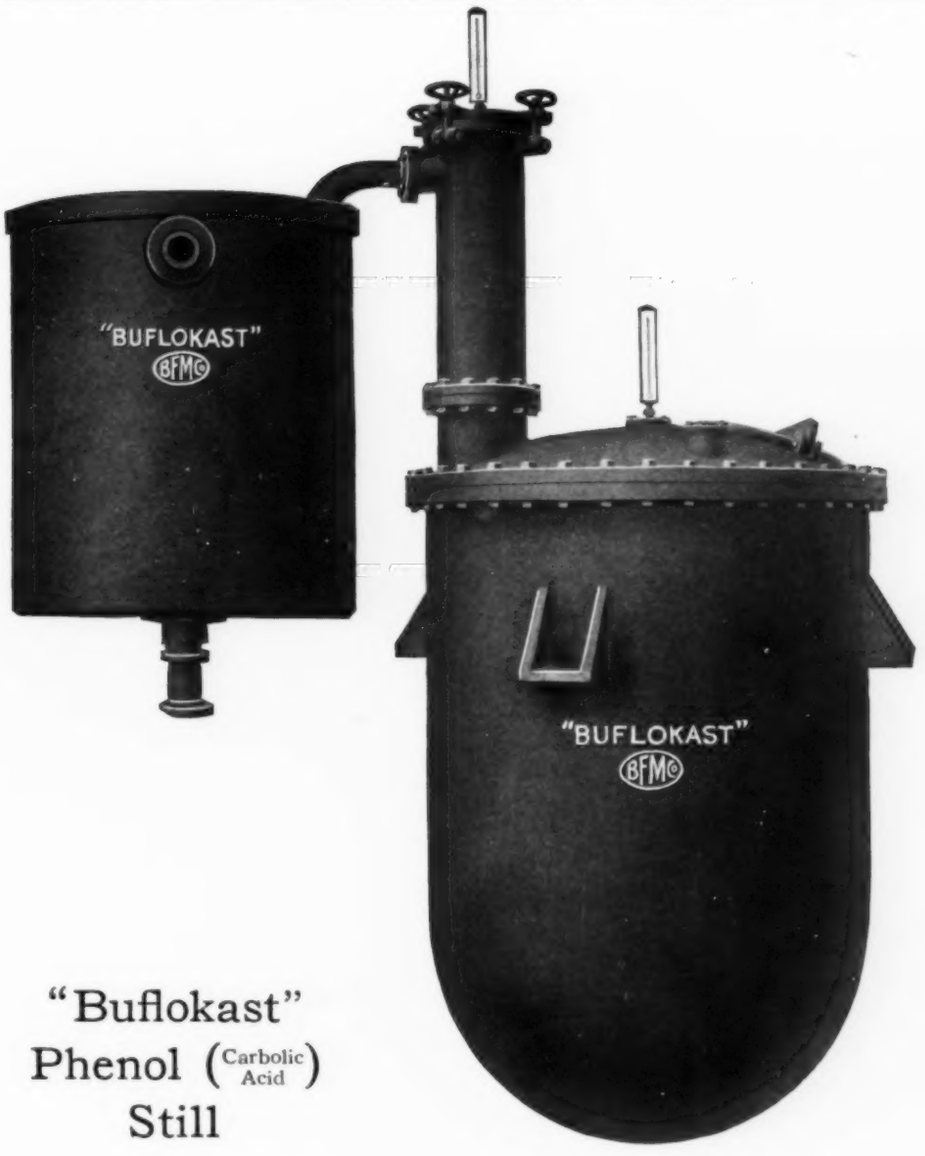
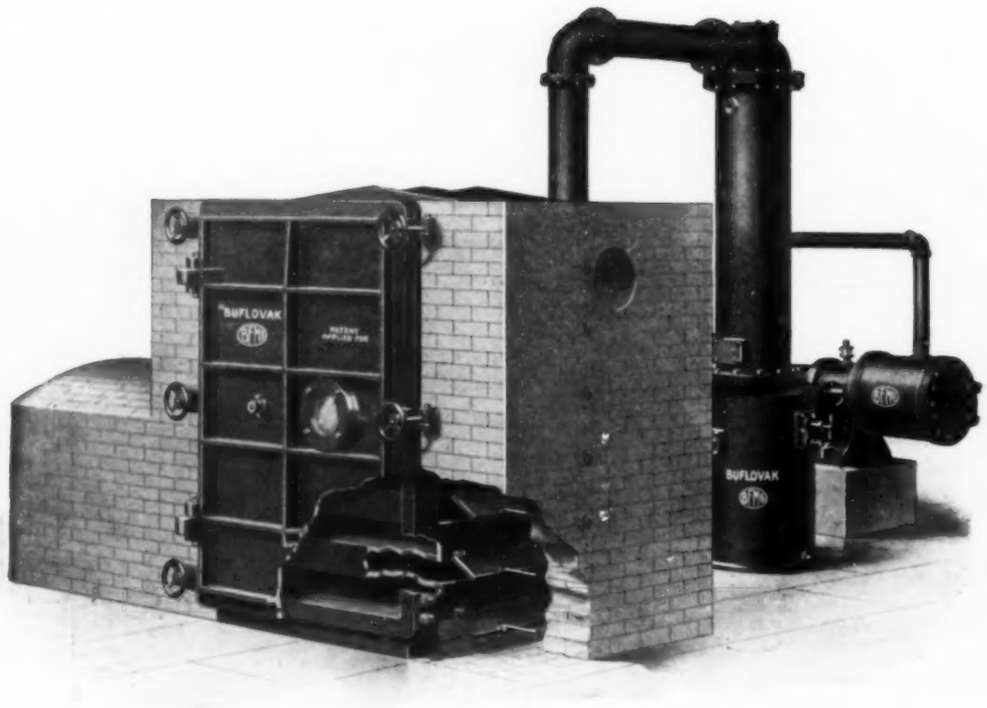


"Buflokast" Phenol (Carbolic Acid) Still

An efficient apparatus working successfully in many installations. Noted for its simplicity in design and durability in service. Constructed of a mixture of metal with special reference to the action of the acids combined with the temperature of the still while in service.

The top of the still is provided with a large manhole with cover, and an extended pocket for holding the charcoal basket, the latter being a special provision for deodorizing the vapors passing from the still to the condenser.

The condenser is arranged for water supply at the bottom and overflow at the top and is fitted with a special coil to prevent discoloration of the acid. The still is provided with lugs on the side for supporting the same on brickwork or furnace top. Built in varying sizes as desired, the illustration showing one of 980 gallon capacity, when full.



"Buflovak" Direct Heat Shelf Retort

Used in the manufacture of Sulfanilic and Naphthionic Acids, and for reclaiming high boiling point solvents where solid materials must be heated and temperature control is of great importance. It is provided with ducts passing from one side to the opposite side. Shelves are formed between the ducts. A full length door is provided on one side of the retort. The retort can be operated under vacuum and is connected with a dry vacuum pump and condenser as illustrated.

The material is placed on the shelves in pans, and the hot gases from the furnace, in which the retort is placed, pass through the inside of the shelves. Waste heat from a boiler furnace can also be utilized.

The regulation of the temperature of each shelf is made by dampers which permit more or less of the hot air to pass through the shelf.

This retort is far more efficient and has a much larger capacity than the types previously used for this purpose and is much more rapid in its operation.

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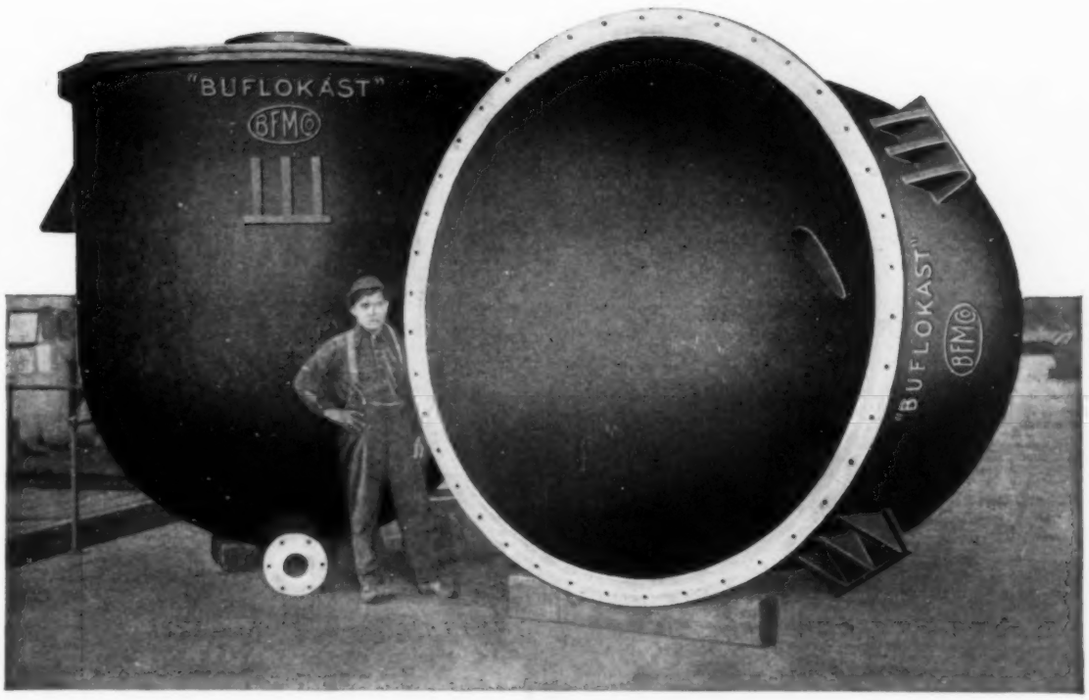
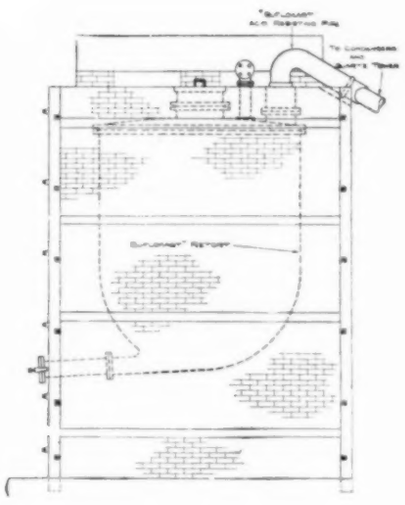


"Buflokast" Nitric Acid Plants



The etching shows the latest practice in nitric acid manufacture which is noted for its efficiency and economy, and is conceded to be by far the most satisfactory method of manufacturing nitric acid.

"Buflokast" retorts are being used by most of the high explosive companies and other manufacturers of nitric acid. These retorts are furnished independently of the complete plant when so desired.

The manufacture of these retorts is an example of what can be accomplished by exceptional facilities, correct foundry and metallurgical methods. Furnished in the vertical or horizontal types as required.

STANDARD SIZES, VERTICAL TYPE

Diameter	Depth	Holding Capacity Gallons
6′—0″ 8′—0″	6′—5″ 9′—8½″	1150 3100

Other Sizes and Special Types Built to Order

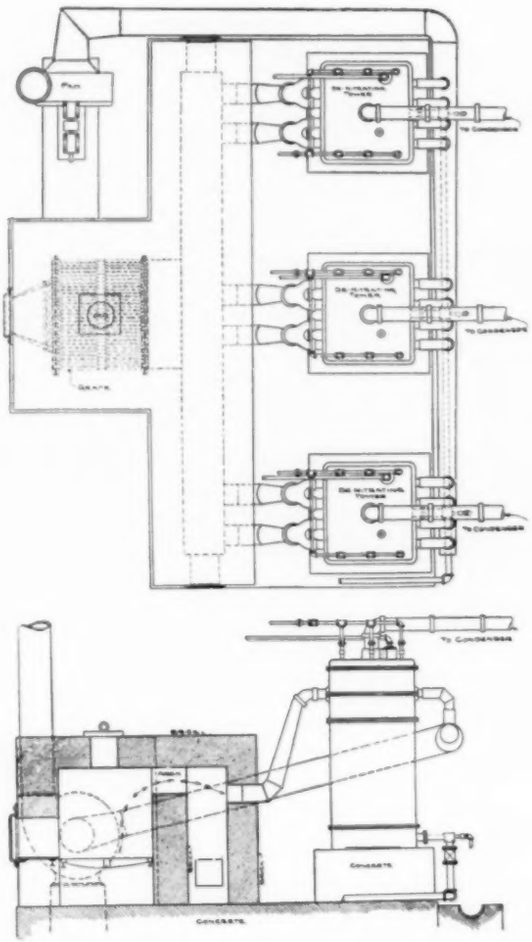
"Buflokast" Denitrator

Used for the recovery of nitric acid from *waste acids* containing as low as 2 per cent. nitric acid and up to 30 per cent. water, particularly from the waste acids obtained in the manufacture of Gun Cotton, TNT, Dinitrobenzol, etc.

The nitric acid is recovered in a more highly concentrated form than is possible with the older process, whether of the distillation or steam separation type. It also has this advantage over the latter process that no steam is used for separating the acids, and consequently the sulphuric acid is not diluted with steam condensation. The additional work of evaporating condensed steam is, therefore, eliminated.

Other advantages over the older processes are as follows: It occupies only one-sixth of the space formerly required; has a much longer life; vapor cannot become superheated or decomposed, which accounts for the great purity of acid obtained; larger heating surface in contact with the acid mixture; oxidizes a larger percentage of lower oxides of nitrogen; and eliminates the sediment usually found at the bottom of ordinary stills. *No objectionable fumes.*

The results obtained with this denitrator may be judged from the facts that the nitric acid is recovered as 90 to 94 per cent acid, the nitrous compounds as 50 per cent nitric acid, and the sulphuric acid with a strength 73 to 78 per cent.



Furnished in units of one, two or three denitrating towers.

The sulphuric acid may be further concentrated in a "Buflokast" concentrating pan made of acid-resisting metal, from which it can be recovered in any desired strength up to 98 per cent.

Cascade Recovery Systems

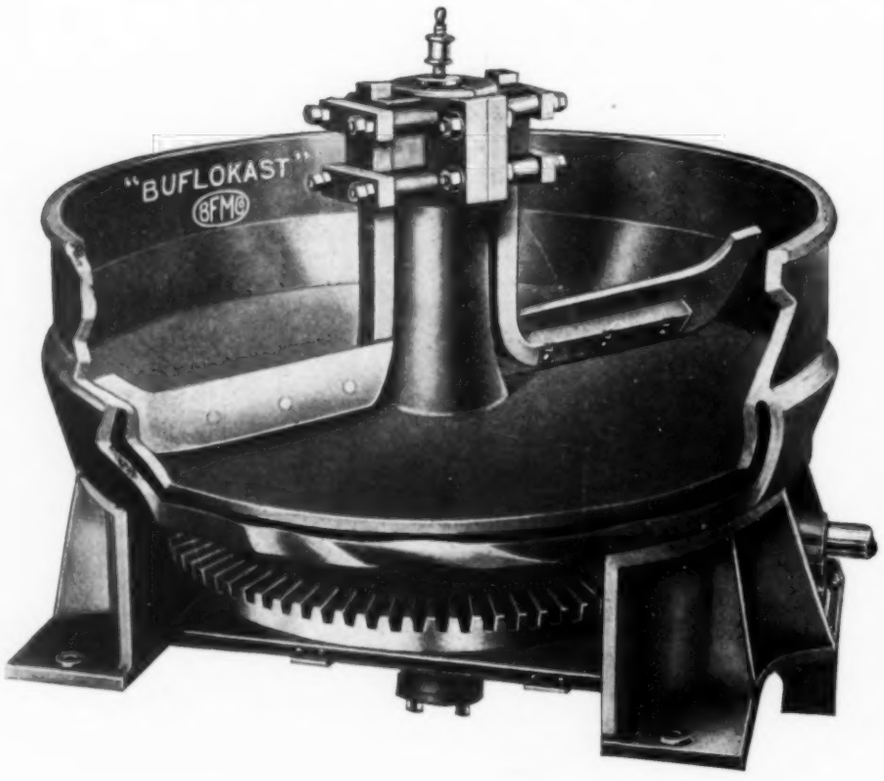
We also furnish, where desired, the cascade system equipped with "Buflokast" acid resistant covered pans, absorption towers, coolers, etc.

1543 FILLMORE AVENUE, BUFFALO, NEW YORK

"Buflokast" Acid Eggs

Made in many sizes and types, horizontal and vertical, for various pressures, and to suit the special requirements of each case. "Buflokast" Acid Eggs are particularly noted for their durability, made as they are with a view to the service for which they are intended. Sizes run from 25 gallons to 1000 gallons.

BUFFALO FOUNDRY AND MACHINE COMPANY



"Buflokast" Crystallizing Pan

Used for concentrating and crystallizing various products, especially Ammonium Nitrate, TNT, etc. Note the one-piece construction of the jacket, a special and exclusive feature of the "Buflokast" Crystallizer. This eliminates all joints as well as the use of bolts, packing, etc. The advantage of this construction is obvious and requires only to be mentioned to be appreciated. Furnished with paddles of steel, cast-iron or bronze, depending on material to be handled.

The "Buflokast" Crystallizer is used extensively for evaporating the neutralized liquor of ammonia and nitric acid. After the ammonium nitrate comes from this apparatus it is thoroughly dry. Steam is used in the jacket for concentration and cold water for crystallization. Also used as an atmospheric dryer.

STANDARD SIZES

Inside Diameter	Holding Capacity Gallons
3′—0″	50
6′—0″	300

1543 FILLMORE AVENUE, BUFFALO, NEW YORK

"Buflovak" Vacuum Crystallizer

This apparatus embodies the same principles as the non-vacuum crystallizer, shown on the preceding page, except that it is operated under a high vacuum, thus causing more rapid crystallization and also permitting the handling of more delicate materials on account of the lower temperature employed. Excellent for "sticky" materials that become "gummy" or "ball up."

STANDARD SIZES

Inside Diameter	Holding Capacity Gallons
3'—0"	50
6'—0"	300

Special Chemical Castings

Jacketed Sulphur Kettle

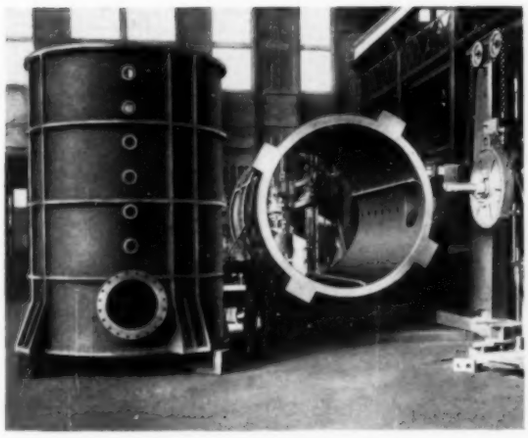
Hydrochloric Concentrating Pan

Besides the standard and special equipment mentioned in these pages, we are prepared to furnish castings for chemical, heat-resisting and other special purposes, having qualities not found in ordinary castings. Our facilities enable us to furnish special castings in any size that can be transported by rail.

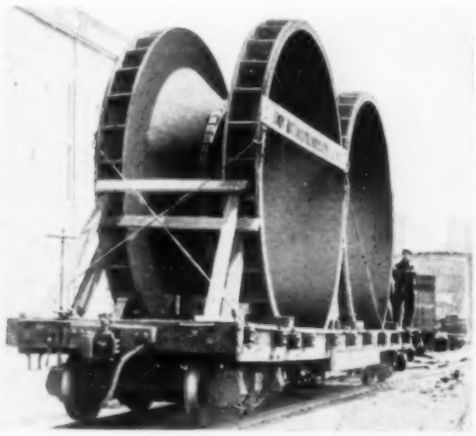
Sulphuric Acid Retort

1543 FILLMORE AVENUE, BUFFALO, NEW YORK

Special Chemical Castings



Special Retort Castings Being Machined

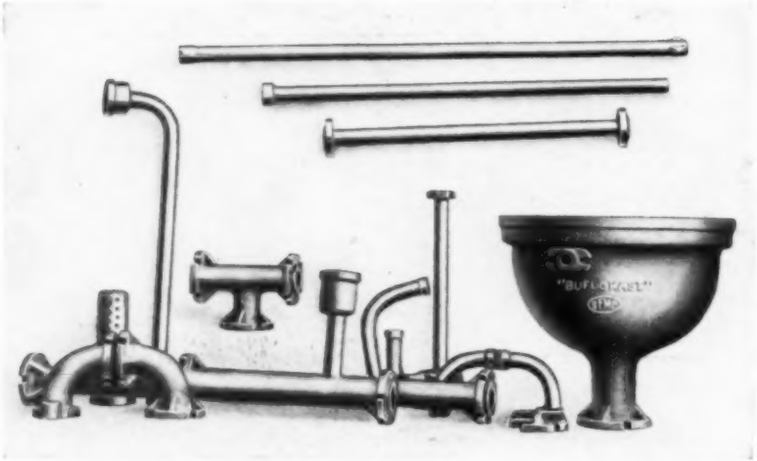


Steep Cone Bottoms Ready to Ship

In making "Buflokast" Chemical Castings all materials used are first chemically analyzed and all meterials used are first chemically analyzed and all metal mixtures produced with laboratory exactness. The result is a finished casting of known qualty with physical and chemical properties suited to the conditions it is to meet.

Dissolving Tanks for Ammonium Nitrate

BUFFALO FOUNDRY AND MACHINE COMPANY

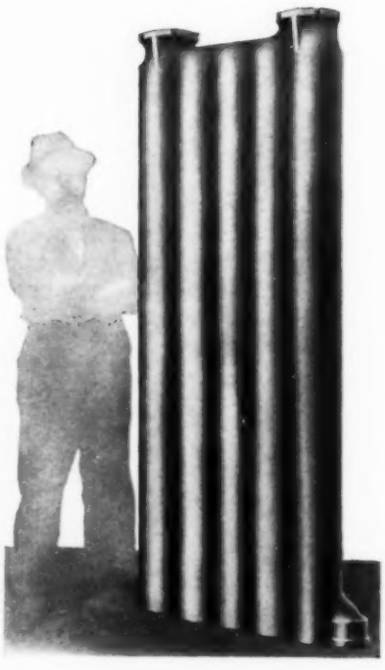


"Buflokast" Acid-Resistant Castings

The illustrations speak for themselves and give some idea of the variety in size and character of "Buflokast" Acid-Resistant Castings.

Our long experience in this work has given us much valuable information as to the best mixtures of metal to use with various dilute and concentrated acids at different working temperatures, and has enabled us to constantly increase the size of the castings in which "Buflokast" Acid-Resistant metal mixtures can be poured.

A special method of reinforcement is used when castings are to be used under pressure.



Closed end tubes 9 ft. long, cast without chaplets

Note uniformity in thickness of metal as shown in longitudinal half section

ACHESON PRODUCTS

ACHESON TRADE ELECTRIC FURNACE MARK GRAPHITE

Electrodes
Anodes
Cathodes
Rods
Tubes
Plates
Discs
Stirrers
Crucibles
Molds
Muffles
Contacts

Also ACHESON-GRAPHITE in powder form for use as dry cell filler, paint pigment, stove polish, electrotypers' leads, in making pencils and for boiler use.

Write for either of the following booklets covering the use of Acheson Electrodes:

Booklet 449-I, Electrolytic Work [*in English*]
Booklet 452-I, Electrothermic Work [*in English*]
Booklet 450-I, Electrolytic Work [*in French*]
Booklet 453-I, Electrothermic Work [*in French*]

ACHESON GRAPHITE COMPANY

Niagara Falls, N. Y., U. S. A.

E. G. Acheson, Ltd., 5 Chancery Lane, London, W. C. 2, England

CORROSIRON

MADE IN U.S.A.

"S" PIPE CAST WITHOUT CHAPLETS

THIS is but one of many uses for corrosiron. Wherever a thoroughly chemical-resistant metal is required it will pay to investigate Corrosiron.

For—

GLOBE VALVES PLUG COCKS PUMPS
GLASS TUBE CLAMPS PULSOMETER BOTTLES
CONCENTRATING PANS

General Castings of Simple or Intricate Forms.

Send—

for sample of corrosiron and test it in your own plant.

In the West:

PACIFIC FOUNDRY COMPANY

Harrison and Eighteenth Sts., San Francisco, Calif.

In the East:

BETHLEHEM FOUNDRY & MACHINE CO.

127 Front St., South Bethlehem, Pa.

BADGER SERVICE

American Spray Installation at B. F. Goodrich Co., Akron, O.
Cooling 20,000 gallons per minute

Badger Service and Badger Quality have been extended to include the application of sprays to the Chemical Industry.

Particularly interesting at this time is the reduction of power costs

By installing our

Spray Cooling Ponds

Send for our bulletins and let us assist in solving your problems.

E. B. BADGER & SONS CO.
AMERICAN SPRAY DEPARTMENT
73 PITTS STREET BOSTON, MASS.

BADGER QUALITY

Going to Build ?

There Is Only One Sensible Rational Way

This Is the Way It Works

We act in the capacity of Engineers, Architects and Constructors.

While you absolutely control every building operation and every expenditure, we, as your agents, relieve you of all details of acquiring all material and labor, superintending of construction and installing of machinery. You control, we execute.

The practicability of this plan has been proven for 15 years. Investigate it. It's a profitable, sensible, modern way to build. Let us explain its advantages.

Samuel M. Green Company
Incorporated
ENGINEERS
Architects—Appraisers—Constructors
Springfield, Mass.

The GREEN Single Profit Plan of Plant Construction

NORWALK
AIR & GAS · COMPRESSORS

Proof of Norwalk Quality

An Installation of Norwalks at World's Largest Liquid Air Plant

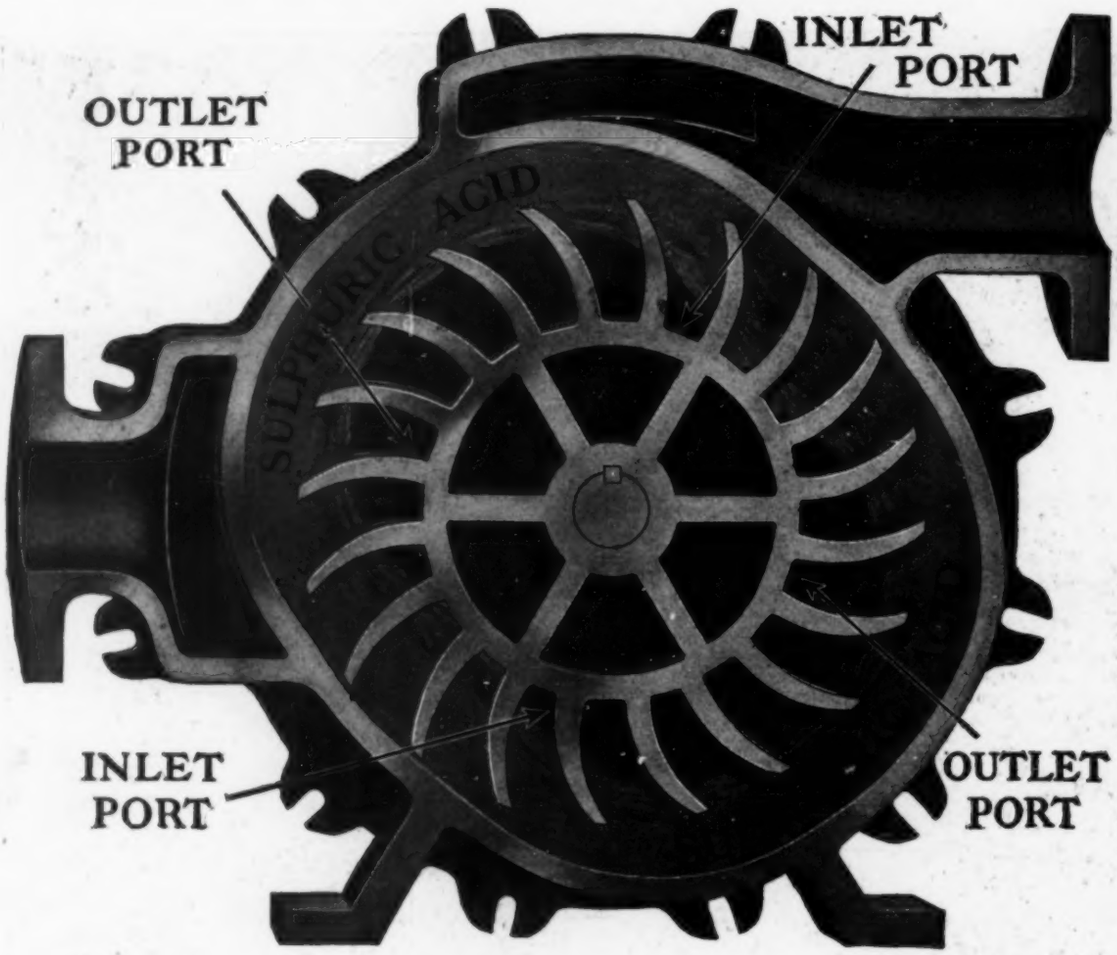
Illustrated bulletins describing Norwalk compressors for air, oxygen, hydrogen, acetylene and carbonic acid gas sent—one or all—upon request.

Norwalk Iron Works Company, South Norwalk, Conn.
Pioneer Builders of Compressors

ANY·CAPACITY ANY·PRESSURE

NASH HYTOR—

The Simplest Vacuum Pump or Compressor



THE pump for air, industrial gas, or acid gas. No valves. No gears. No pistons. No piston packing. No sliding vanes. No interior lubrication necessary. Absolutely clean air, delivered without pulsation. Various liquids are used as the displacing medium depending on the gas to be handled. Rotor only moving part, cast in one piece, heavily shrouded, and mounted on ball bearings outside of casing. Long life. Constant efficiency. Positive service.

NASH ENGINEERING CO.

South Norwalk, Conn., U. S. A.

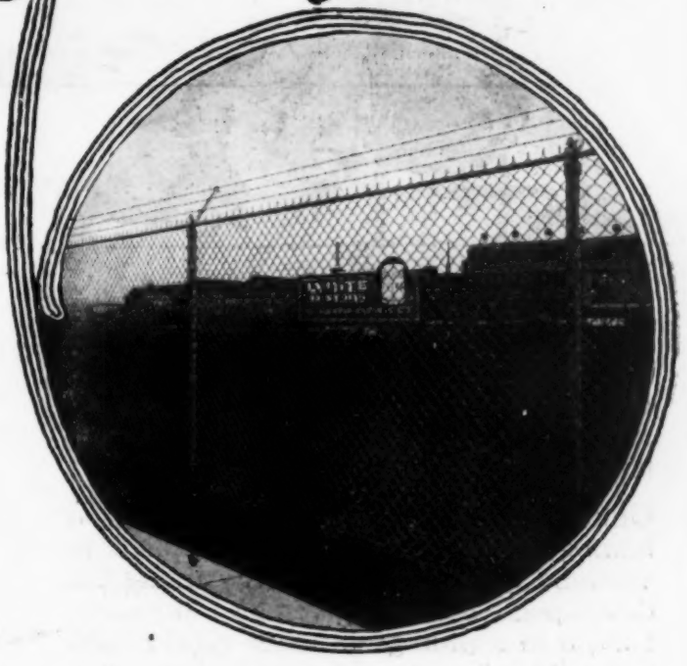
=playing in your yard?

A mob never could were it Anchor Post protected.

An Anchor Post Chain Link Factory Fence forms an unclimbable, unburnable stockade that cannot be pulled down or broken through. It is an ever vigilant watchman, on duty all day and all night.

Heavily galvanized to prevent rust and corrosion, each post is securely anchored in a manner that prevents sagging or up-rooting. Actual experience has proven these Anchor Post Fences as serviceable after ten years' use as the day they were erected.

Telephone or write our nearest office. An interesting catalog and intelligent co-operation will show you how economical a good fence really is.



ANCHOR POST IRON WORKS

167 Broadway, New York, N. Y.

Boston, Mass., . 79 Milk St. Hartford, Conn., 902 Main St.
Cleveland, O., Guardian Bldg. Philadelphia, Pa.
Chicago . . Hartford Bldg. Real Estate Trust Bldg.

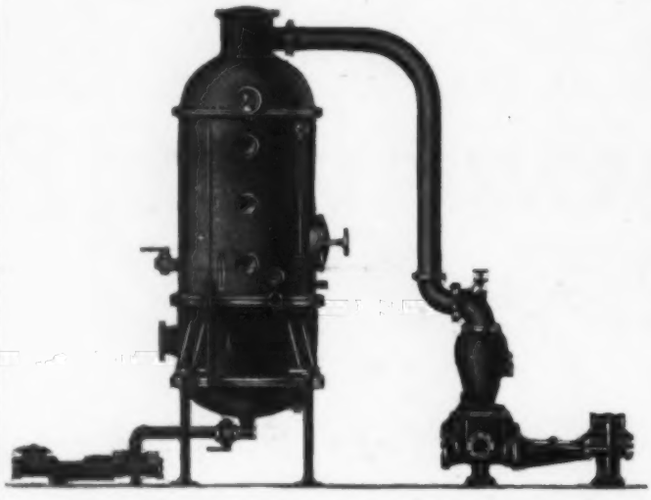
Anchor Post Fences

2267-G

SPECIAL MACHINERY APPARATUS IN COPPER, IRON, STEEL, LEAD, ETC.

We specialize in the design and construction of special machinery and equipment for the Chemical and Allied Industries. Our products include:

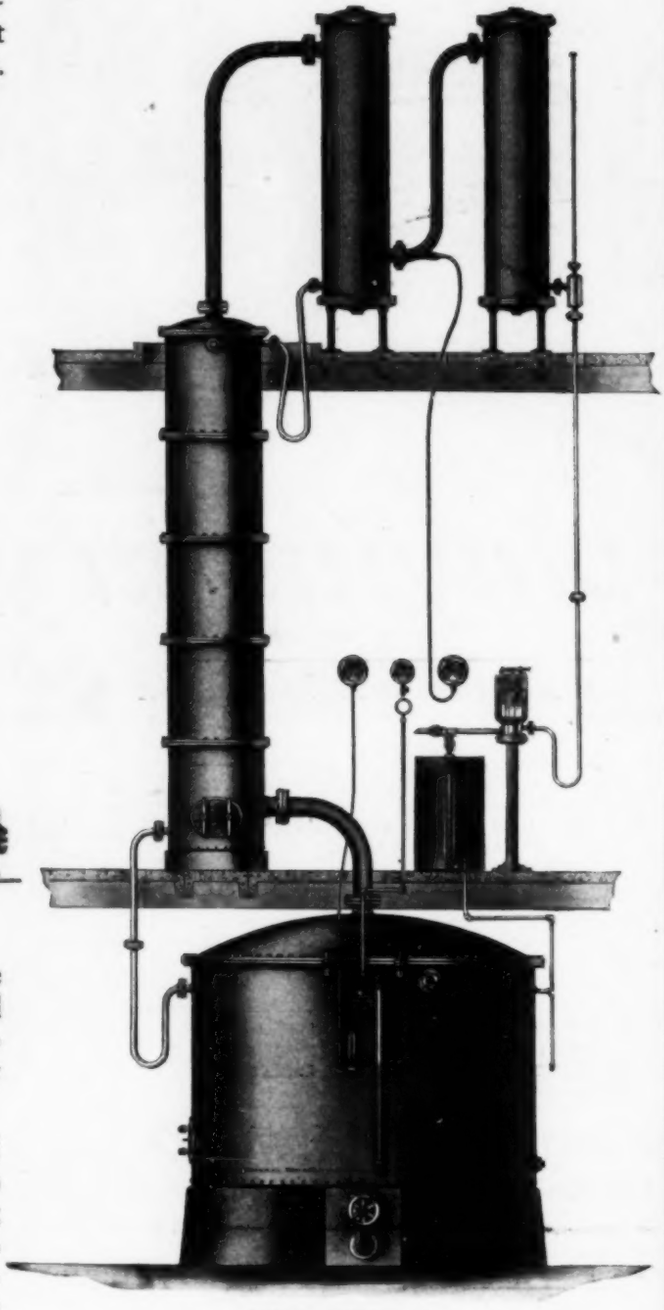
Evaporators, in single and multiple effects,
Distilling Apparatus—continuous and periodic, pressure and vacuum,
Extractors—batch and diffusion battery types,
Vacuum Pans, Kettles,
Condensers, Coolers,
Milk Pans, Tin and Lead Lined Apparatus.



Single Effect, Vertical Tube, Vacuum Evaporator

Our equipment is designed in accordance with the most up-to-date and accepted engineering practice, while the workmanship embodied therein is of the very highest grade.

Our "ZEITLER" patented method of homogeneous lead lining as applied to vacuum apparatus is the only lining yet developed which has given absolute satisfaction in standing up under rigid conditions. This lining can be applied to either copper or steel.



Periodic Refining Still

The Oakland Copper & Brass Works

Chemical Engineers and Constructors

Seventh & Kirkham Sts., Oakland, Calif.

Nelson Electrolytic Chlorine and Caustic Soda Cell

After a most thorough investigation the United States Government selected the Nelson Cell for the largest Chlorine plant in the world. This plant started operation 100 days after ground was broken, delivering Chlorine of the highest purity, exceeding all guarantees and by its remarkable performance, which has never been equalled, proved the wisdom of the Government's choice.

Above is one of eight cell rooms, each containing 444 Nelson Cells.

We have installed over 8,000 Nelson Cells for the production of Chlorine Gas and Caustic Soda.

Among the satisfied users of this cell are:

Semet Solvay Co.
E. I. duPont deNemours & Co.
Gulf Refining Co.
Roessler & Hasslacher Co.
Republic Chemical Co.
Warner-Klipstein Chemical Co.
Rollin Chemical Co.
Baltimore Copper Smelt. & Roll. Co.
Southern Reduction Co.
Montclair Water Works.
Isco Chemical Co.
Hammersley Manufacturing Co.
Commercial Research Co.
Nankai Sarashiko Kabushiki Kaisha
Osaka Semi Co.
Edgewood Arsenal U. S. Govt.

THE WARNER CHEMICAL COMPANY

52 Vanderbilt Avenue, New York City

FACTORY FOR JOHN B. SEMPLE & COMPANY, STOOPS FERRY, PA.

GETTING *THE* CONTRACTOR IS MORE IMPORTANT THAN GETTING *A* CONTRACT!

Your plant extension must comprehend something more than the mere letting of a contract if it is to add to the efficiency of your operations as well as to their scope.

If you will let us confer with you on the matter, it is almost certain that we can evolve from an analysis of *your problems* and *our experience,* suggestions which you will find it beneficial to adopt.

All that we ask is a conference.

The contract will take care of itself.

Our Advice is as Good as Our Service

THOMPSON-STARRETT COMPANY

INDUSTRIAL CONSTRUCTION

NEW YORK

CHICAGO **DETROIT** **PITTSBURGH**

THE WELL KNOWN

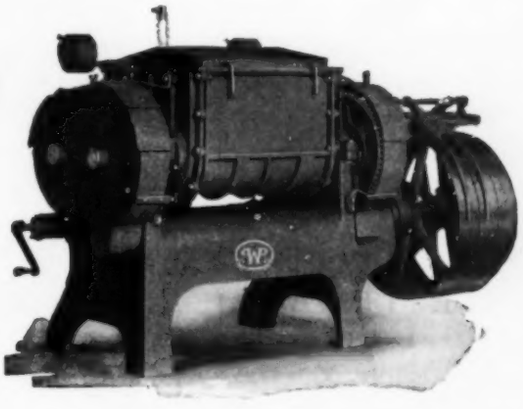
The Leaders

who buy full page advertising cannot afford to jeopardize either their investment in advertising, or the *"Good Will"* created through it.

This is one of the reasons why they use only the *highest grade* machinery in the manufacture of the products with which they back up their advertising.

The full page advertisement, reproduced here by permission, is backed by products in the manufacture of which our *"Universal" Kneading and Mixing Machines* play an important part.

"UNIVERSAL" KNEADING AND MIXING MACHINES



are built in sizes ranging from one-quarter gallon to 2650 gallons working capacity and in a number of different Types, Classes and Special Constructions.

A "Universal" Kneader for Every "Knead"

WERNER & PFLEIDERER CO.
2816 NORTH NIAGARA STREET
SAGINAW, MICHIGAN

New York Woolworth Bldg. | Philadelphia Drexel Building | Cleveland Hippodrome Bldg. | San Francisco Pacific Building

GLASCOTE

Means Seamless Glasscoated Steel Equipment

It represents the most modern development in seamless glass lined equipment, and is an incomparable product for general chemical work, especially where accurate results are essential in the handling of sensitive and corrosive liquids.

GLASCOTE contains no Metallic Oxides. It is a Pure White Boronsilican Glass.

GLASCOTE is a Product of the U. S. A. and equals any that was formerly imported.

GLASCOTE being pure white, greatly aids the observation of Chemical Reactions.

Our engineering staff and laboratory is at the disposal of those desiring to secure utmost service from their equipment.

CHEMICAL BULLETIN mailed upon request.

Seamless Jacketed Mixer
lined with
PURE WHITE BORONSILICAN GLASS

Types of Glascote Equipment

Mixing Tanks
Evaporating Tanks
Crystallizing Tanks
Storage Tanks
Jacketed Kettles
Vacuum Stills
Autoclaves
Cascade Dishes
Reflux Condensers
Distilling Condensers
Containers
Kettles with Tilting Frame and Pouring Lip
Jacketed Kettles fitted for Hot Oil or Steam Circulation or Any Practical Heating Medium
Made in all practical sizes
Carefully Designed Well-Built, Dependable Equipment

Sign of Service

Our nearest branch office will immediately furnish complete information, catalogs, prices, etc.

For chemical plants, food product industry, essential oils, perfumes, extracts, syrups, beverages, etc.

THE GLASS COATING COMPANY

CLEVELAND, OHIO.

NEW YORK OFFICE
50 East 42nd Street

CHICAGO OFFICE
220 State Street

SAN FRANCISCO OFFICE
Rialto Building

Why Not Ask Somebody

about Ridgway elevators before buying elevators and save your reputation?

Here are some Chemical fellows who have "Hooked 'er to the Biler":

Merrimac Chemical Co.	Standard Oil Co.	Barrett Co.
Dow Chemical Co.	E. I. du Pont & Co.	Packard Motor Car Co.
Columbia Chemical Co.	Larkin Co. (soap)	B. F. Goodrich Co.
Mathieson Alkali Co.	Curtis Bay Chemical Co.	General Chemical Co.
Avery Chemical Co.	Welsbach Co.	Diamond Alkali Co.
Beckton Chemical Co.	Diamond Match Co.	Solvay Process Co.
Rollin Chemical Co.	Sherwin, Williams & Co.	Am. Smelting & Ref. Co.

Here are some Paper Mills who have "Hooked 'er to the Biler";

Marathon Paper Co.	Orono Paper Co.	Thames River Paper Co.
Thilmany Paper Co.	Eastern Mfg. Co.	River Raisin Paper Co.
De Grasse Paper Co.	Megargee Paper Co.	Colin Gardner Paper Co.
Flower City Paper Co.	Wrenn Paper Co.	International Paper Co.
American Writing Paper Co.	Crocker-Burbank & Co.	Ticonderoga Paper Co.
	Joliet Paper Co.	Mohawk Valley Paper Co.
Nekoosa-Edwards Co.	Smith & Ault Paper Co.	Kingsport P. & Paper Co.
Watervliet Paper Co.		

Here are some Gas Works who have "Hooked 'er to the Biler":

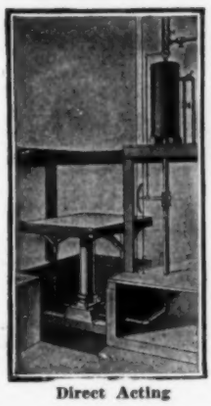
United Gas Imp. Co.	Meriden Gas Co.	Springfield Gas Co.
Philadelphia Gas Wks.	Bridgeport Gas Co.	Northern Indiana Gas Co.
Consolidated, N. Y.	Albany Gas Co.	Mobile Gas Co.
Consolidated, Boston	Providence Gas Co.	Atlanta Gas Co.
Consolidated, Baltimore	Fall River Gas Co.	Birmingham Gas Co.
Peoples of Chicago	Hartford Gas Co.	Bristol Gas Co.
Pub. Service of N. J.	Buffalo Gas Co.	Newport Gas Co.

Here are some Packing Houses who have "Hooked 'er to the Biler":

West Phila. Stock Yards.	Central Products Co.	Roth Packing Co.
Reading Abattoir Co.	Ferguson Packing Co.	Klinck Packing Co.
Miller & Hart	John J. Felin & Co.	Kingan Co.
Roberts & Oake	Shenandoah Pack. Co.	Kansas City Pack. Co.
John Morrell & Co.	Croninger Pack. Co.	Louis Burk
D. B. Martin & Co.	Val Decker & Co.	John D. Buckley Co.
Wilson & Co.	Thos. Kurdle & Co.	Wm. Schluderburg & Son

And we could fill this page with other lines among the 2000 to 3000, who will tell you, if you have steam to be sure and

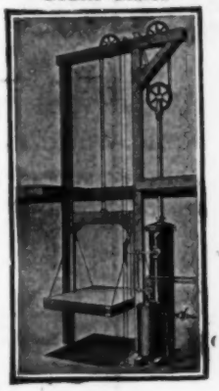
Hook 'er to the Biler

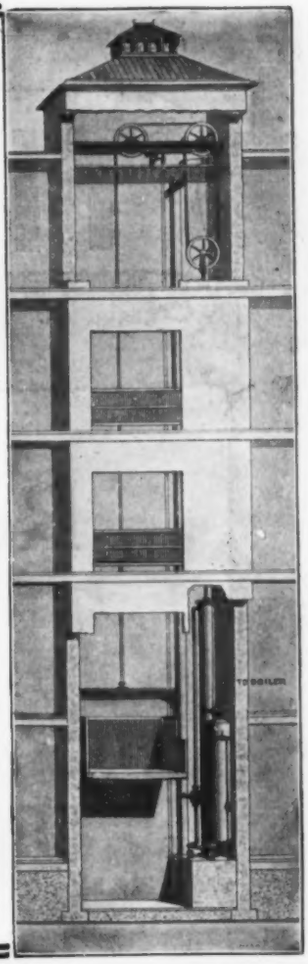


Direct Acting

Over 2000 in Daily Use

Double Geared





CRAIGE RIDGEWAY & SONS CO., Coatesville, Pa.

ELEVATOR MAKERS TO FOLKS WHO KNOW

Vested in Every Taber Pump

are the features of design and the qualities of construction resulting from 30 years of endeavor to attain and maintain the highest standards of pump efficiency.

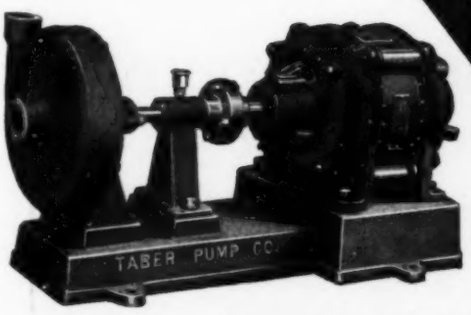
The "V" Type Centrifugal

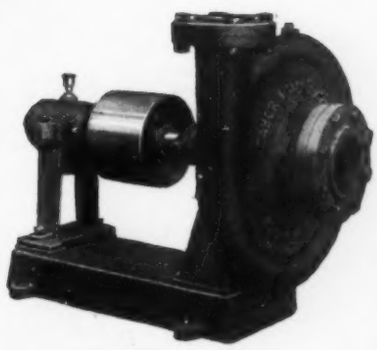
is a high-class simple suction, open impeller type pump developed to meet a growing demand.

The pump can be constructed of iron, composition bronze or acid-resisting bronze.

This type of pump can be furnished for belt drive or direct connected to an electric motor, gasoline motor or steam engine.

Bulletin No. 20





TABER PUMP CO., 237 Elm St., Buffalo, N. Y.

TITANIUM TALKS

No. 47

Reduce Your Costs!!

It is of vital importance to YOU that there be no waste in your plant. The stability of your business depends upon the story your cost statements tell.

Ferro-Carbon-Titanium

"THE FINAL CLEANSER"

in addition to cleansing the steel by thorough deoxidation, greatly reduces segregation, insuring sound, clean steel of uniform composition. This reduces costs by

Increasing the yield of Salable Product

FERRO-CARBON-TITANIUM is made in six sizes to efficiently meet the needs of various methods of Steel Making. Our staff of practical steel men will advise you concerning the most economical size for your business.

IT WILL PAY YOU TO INQUIRE

The Titanium Alloy Mfg. Company

Niagara Falls, New York

Pittsburgh Office. Oliver Building
New York Office, 165 Broadway

FERRO CARBON TITANIUM F.C.T.

Chicago Office, Peoples Gas Building
T. Rowlands & Co., Sheffield, England

Agents for Great Britain and Europe

CHARLES COOPER & CO.

194 Worth Street
NEW YORK

Established 1857

Manufacturing Chemists

A partial list of our products are:

AMMONIA ANHYDROUS
ANTIMONY GOLDEN AND CRIMSON
CHEMICALLY PURE ACIDS AND AMMONIA
COLLODION AND LACQUERS
ETHYL CHLORIDE
NITRATE SILVER
SOLUBLE COTTON AND ITS SOLVENTS
SULPHITE SODA
SULPHUR FLOUR

WORKS AT NEWARK, N. J.
A FULL LINE OF TECHNICAL, PHOTOGRAPHIC AND MEDICINAL CHEMICALS

CRUDE SULPHUR

Guaranteed 99% Pure

For use in Metallurgical field, etc.

THE UNION SULPHUR CO.

17 Battery Place, New York City

CAUSTIC SODA

(Electrolytic)—76 %-74% and 60%

STANDARD BLEACHING POWDER

Liquid Chlorine

PENNSYLVANIA
SALT MFG. COMPANY
Widener Bldg.
PHILADELPHIA, PA.

Ferro-Uranium

The Latest Discovery in Alloys for Efficient

HIGH SPEED and other STEELS of QUALITY

Largest Producers in the World of Uranium

Write Us for Particulars

STANDARD ALLOYS COMPANY

Forbes and Meyran Avenues, Pittsburgh, Pa.

The Roessler & Hasslacher Chemical Co.

Manufacturing and Importing Chemists

Chemicals for All Industries

100 William Street, New York

BRANCHES: Boston, Cleveland, Philadelphia, Chicago, Kansas City, St. Louis, Cincinnati, San Francisco, New Orleans

WORKS: Perth Amboy, N. J. Niagara Falls, N. Y.

Gold Medal Award

Panama-Pacific International Exposition, San Francisco, 1915

"SODIUM CYANIDE"

used in solution for the extraction of precious metals

"CYANEGG" for fumigation in horticulture

"R. H. CASE HARDENER" (granular), for heat treatment and case hardening

Other Gold Medal Awards

Chicago, 1894 Omaha, 1898 Buffalo, 1901

Grand Prize—St. Louis, 1904

Metal Cyanides and Trisalyts for Electro Plating

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99½ Per Cent Pure

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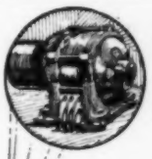

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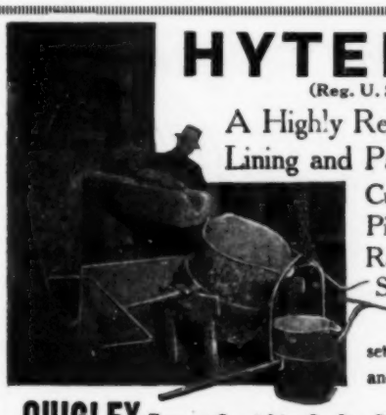

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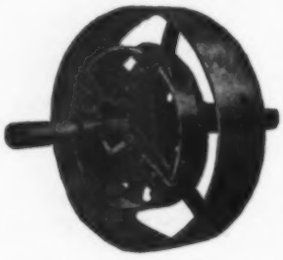

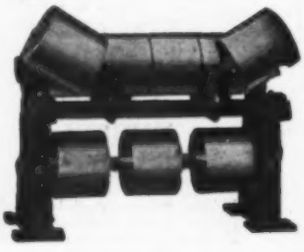

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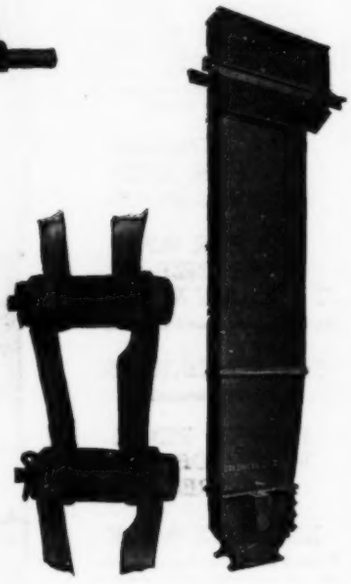

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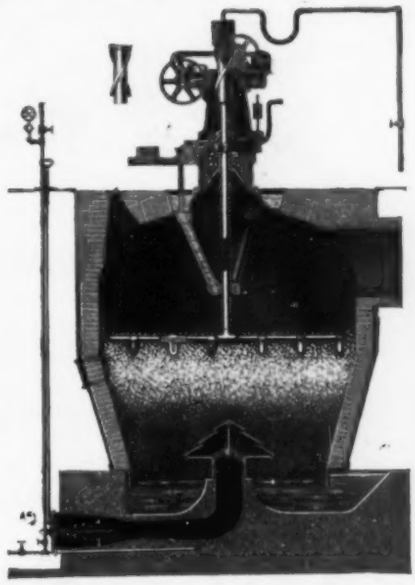

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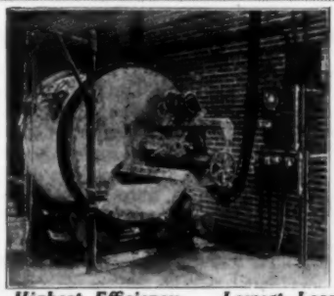

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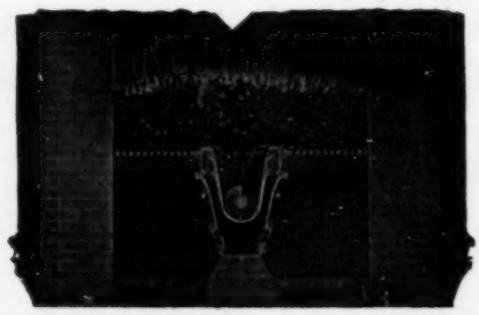

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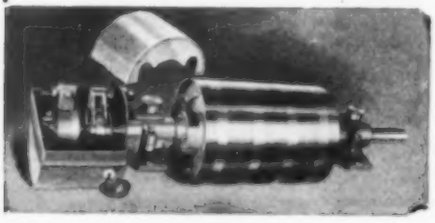

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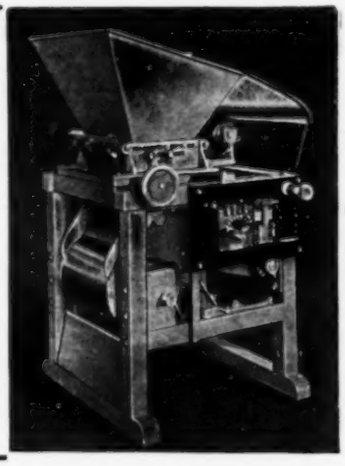

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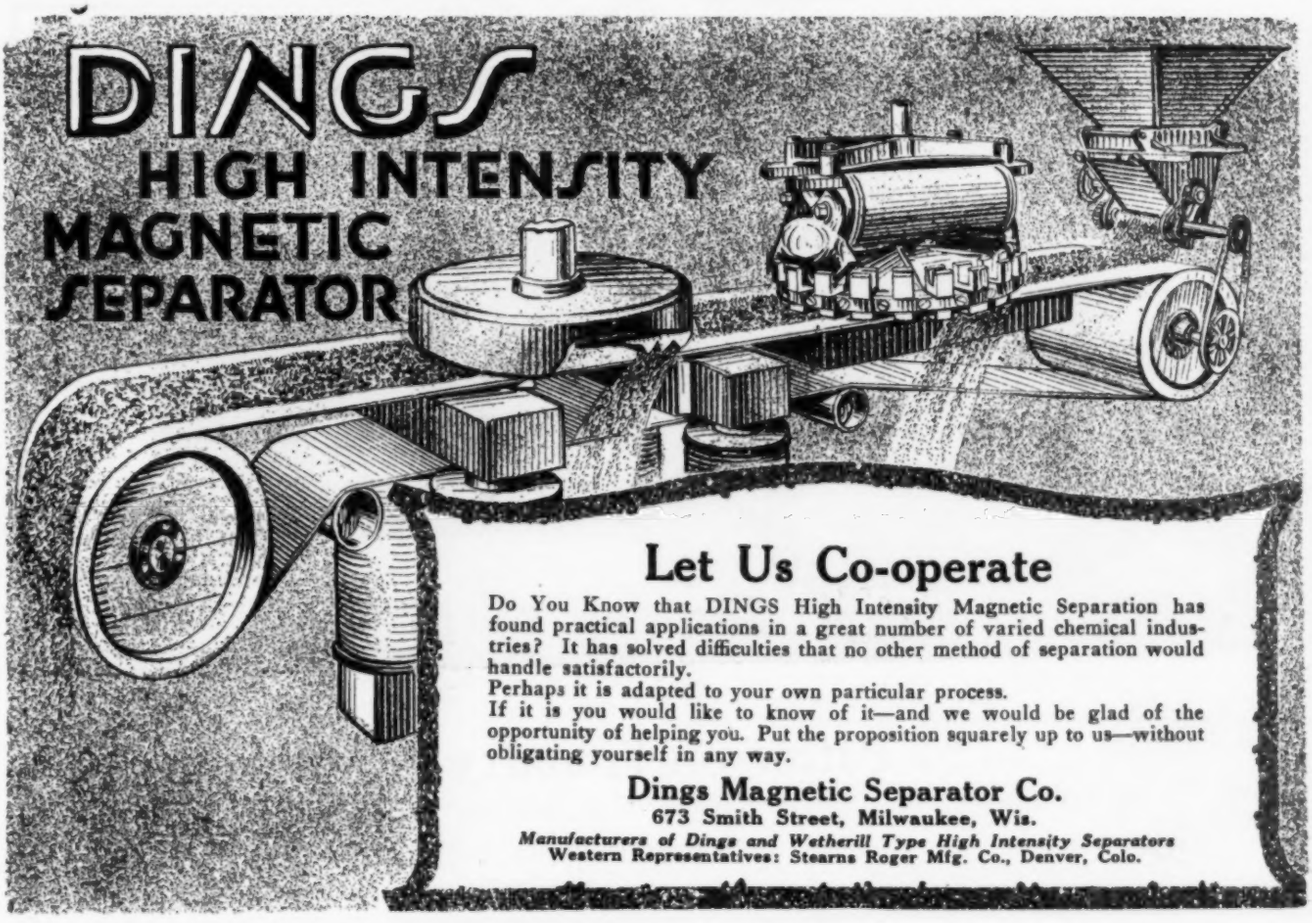

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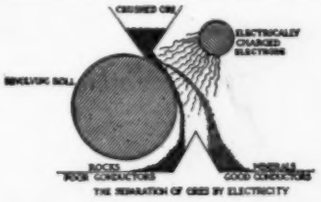

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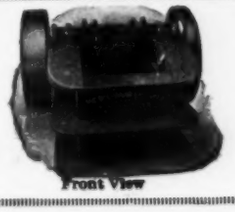
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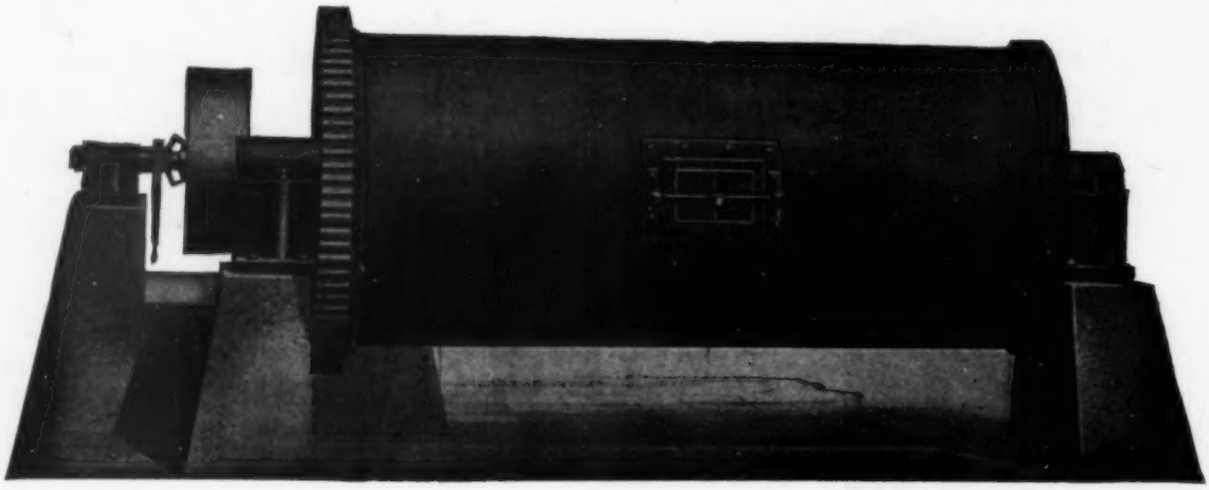

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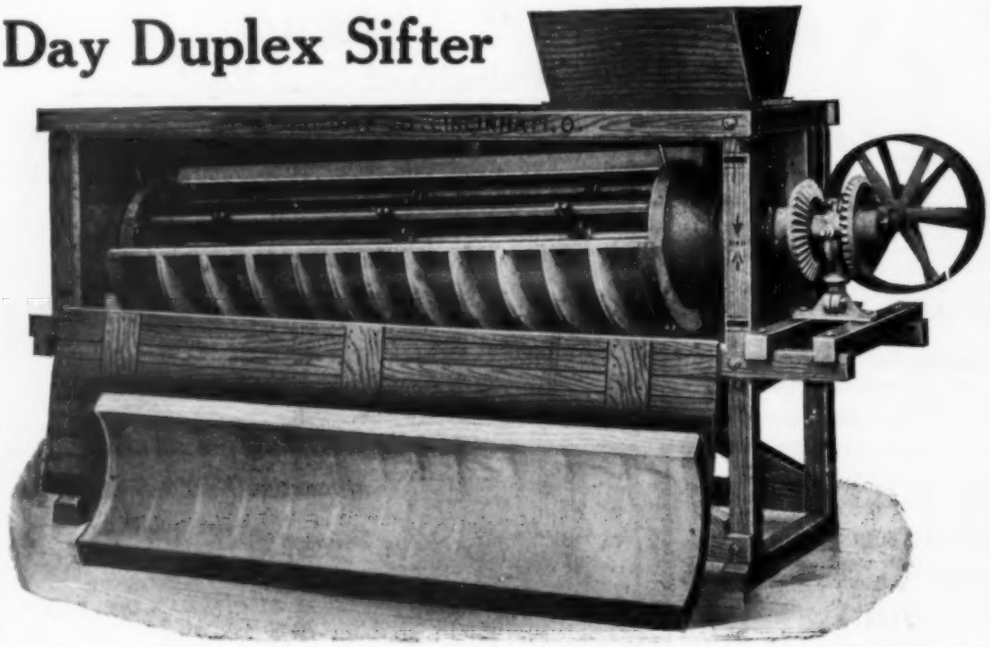

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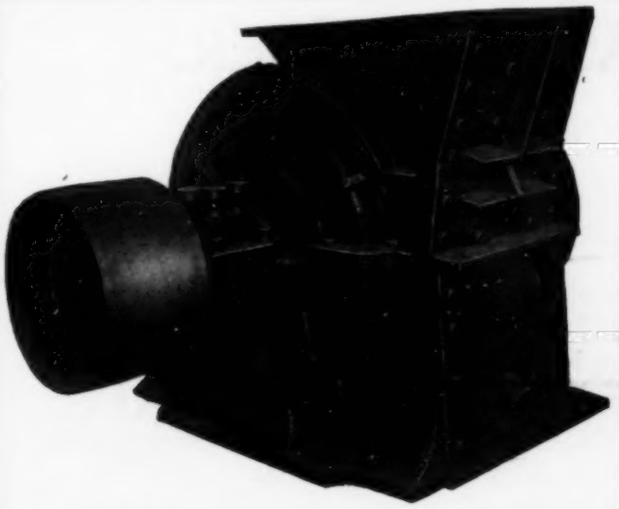

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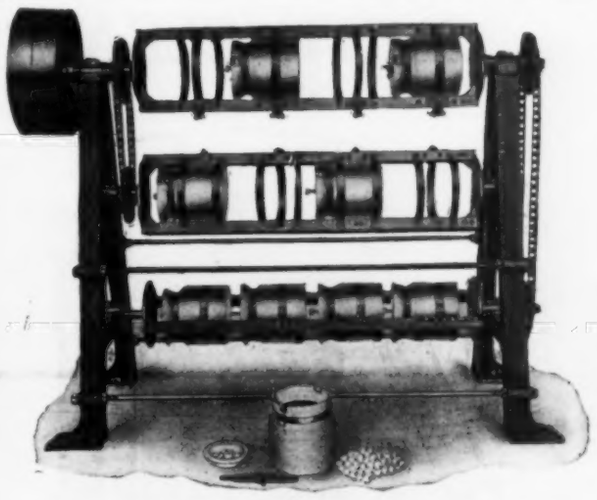

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The best of its type procurable. Equally true of all Abbé Engineering Company machines—characteristic for low power consumption, large capacity, continuity of operation and low maintenance cost.

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THE MAXECON MILL

has been perfected to give the greatest output with least power and wear of any pulverizer even on the hardest and toughest materials.

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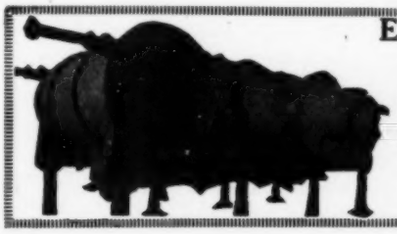

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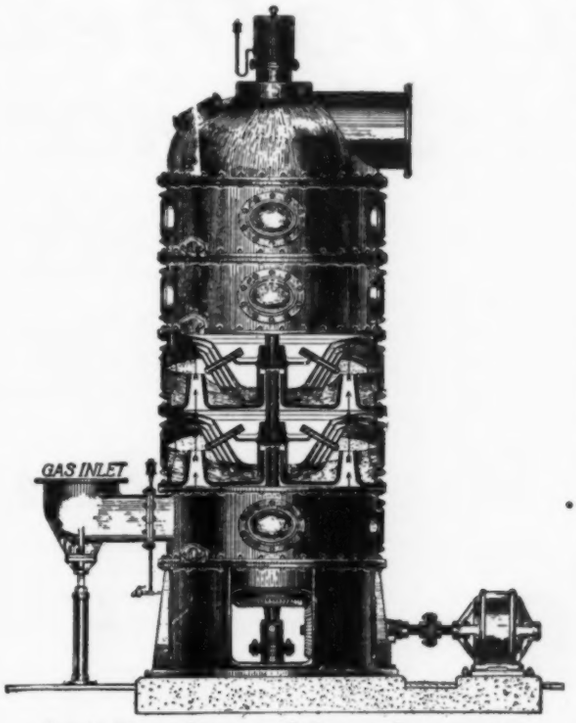

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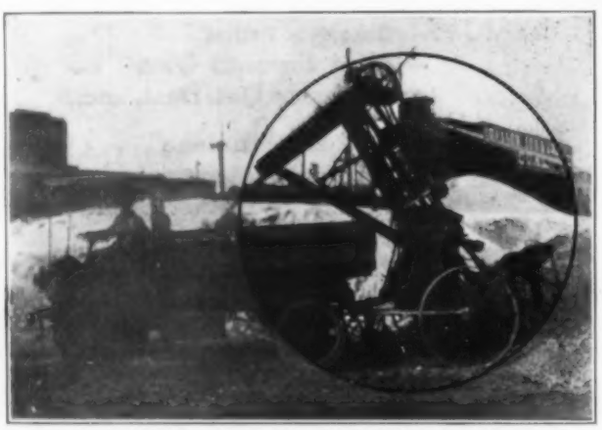
Wherever coal, crushed stone, gravel, sand, clinker, lime, cake, ashes, etc., are handled in quantities. G. W. Wagon Loaders are meeting the severest requirements. Every machine is a product of an organization over 105 years old—with every modern facility.

Because our Engineering Department makes a careful study of each customer's requirements, the proper loader is furnished in every instance.

Special loaders built to meet any unusual conditions. Write our nearest office today for prices, literature, etc.



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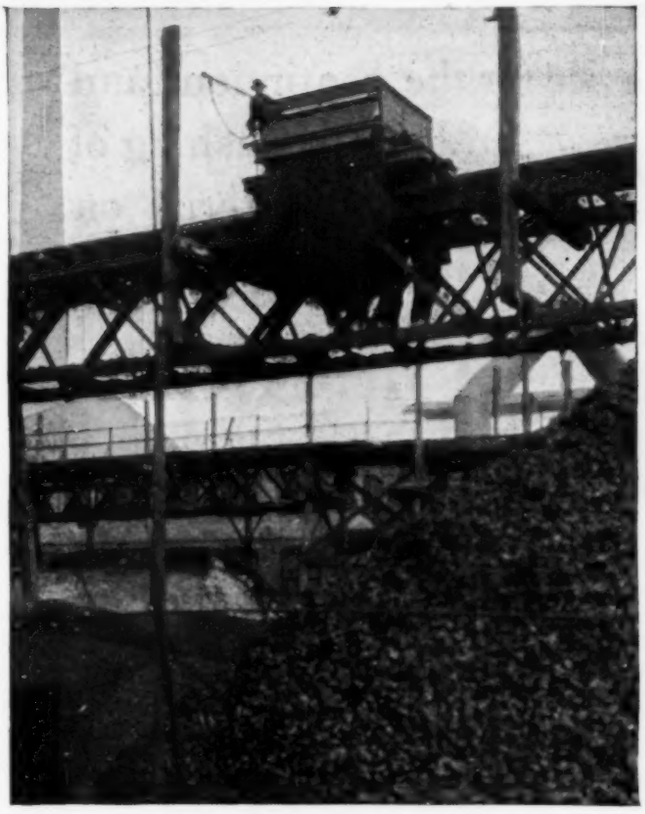

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Handling large quantities of fuel economically calls for an industrial railway system of some sort. And the more closely the system fits the particular situation, the greater the economy.

Easton Industrial Railway Service includes not only the intelligent layout by engineers with a quarter of a century's experience in that particular work, but the manufacture of the proper cars—specially designed, if some one of the great variety of standard Easton cars will not best serve—and the track, switches, turntables and minor details of the equipment.

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Works: Easton, Pa.

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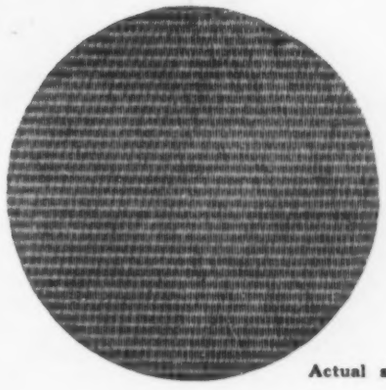
(Patented)



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"Newark" Cloth will better the finest filter. Double filtration surface—in all metals in which a wire can be drawn—Monel Metal, Pure Nickel, etc. Cleans easily. Write for samples.

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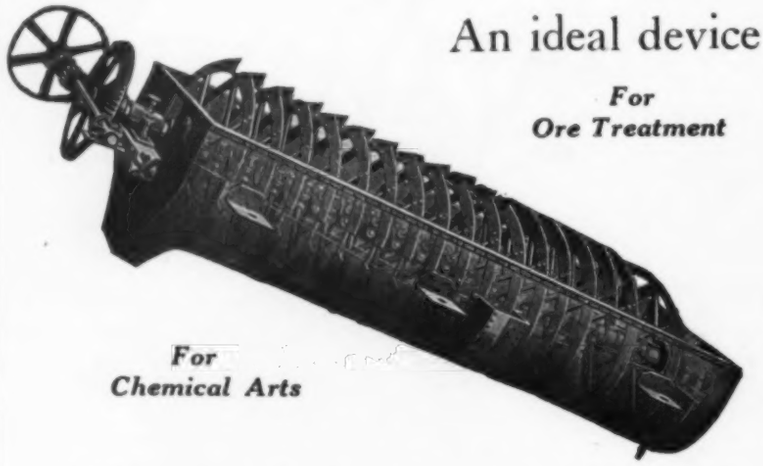

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An ideal device for the continuous and automatic washing of granular material on a large scale

The Akins Classifier

In the treatment of ore it speeds up the regrinding department and improves table recovery. In cyanidation an extremely close separation of the slime is made without the addition of water to the pulp and without supervision. The absence of cams, cranks, lifting devices, connecting-rods, etc., has secured the ready acceptance of the Akins by mill operators, and its superior efficiency has been demonstrated time and again.

Has a wide range of usefulness in analogous separations occurring not only in ore treatment but in other lines where it is desired to continuously wash granular material to recover values carried in the adhering moisture, or where the granular material may be the valuable product.

Bulletin 24-C gives full details.

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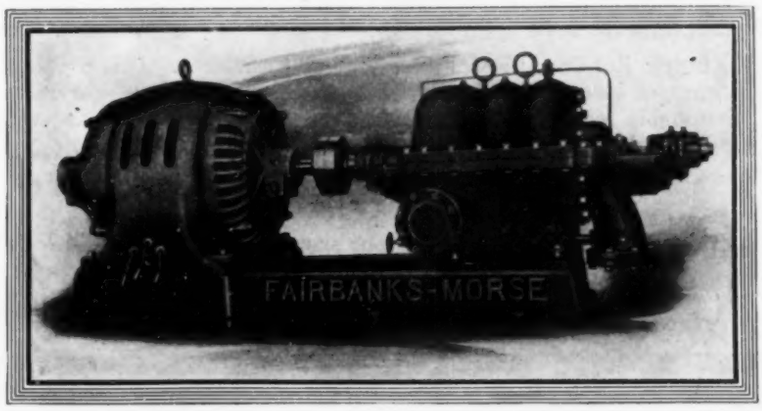

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This Fairbanks-Morse direct connected motor pump unit is designed to operate efficiently in heavy service against high heads. Pump has horizontally split casing—gives easy access to parts. Motor has rigid cast frame—solid metal rotor "cage" winding. Fairbanks-Morse Quality backs up the complete unit—no divided responsibility.

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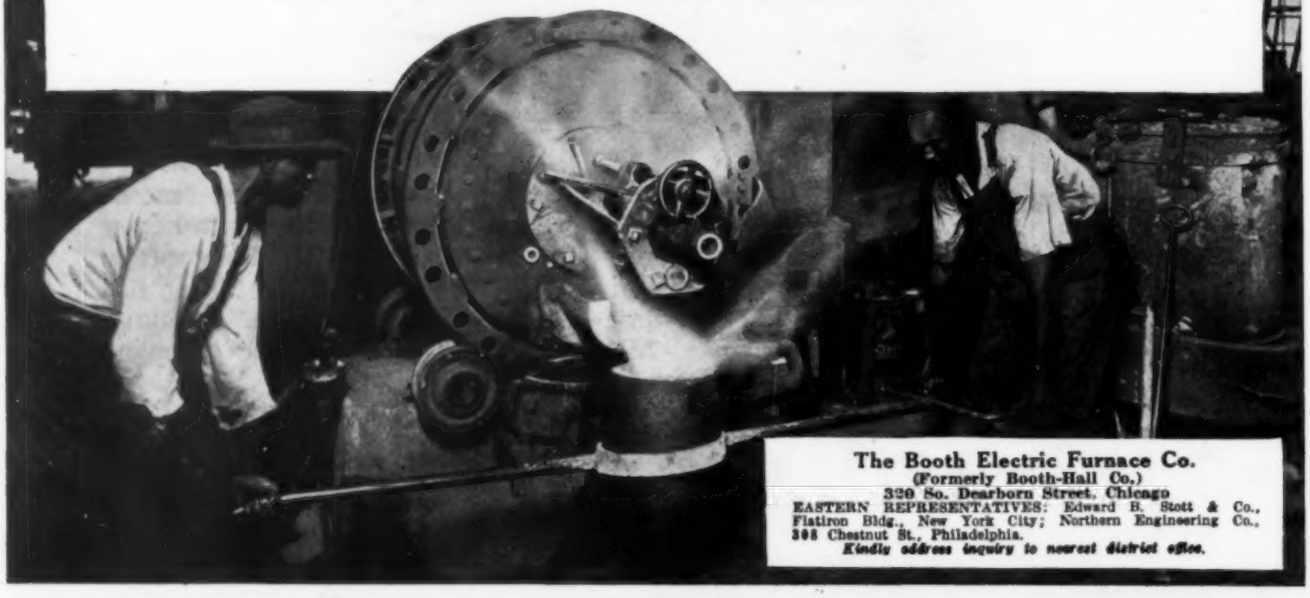

The Booth Electric Furnace Co.
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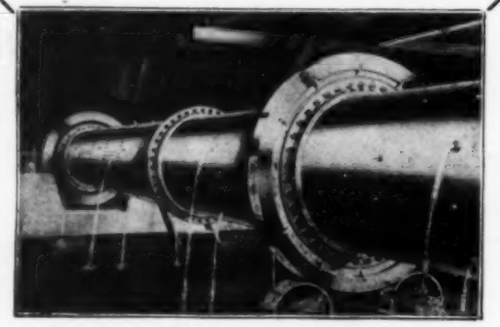

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with your present filter equipment. Chemists have overcome such filtration difficulties as the passage of slimy impurities from metallic solutions—the constant clogging of cloths and the necessity of recrystallization.

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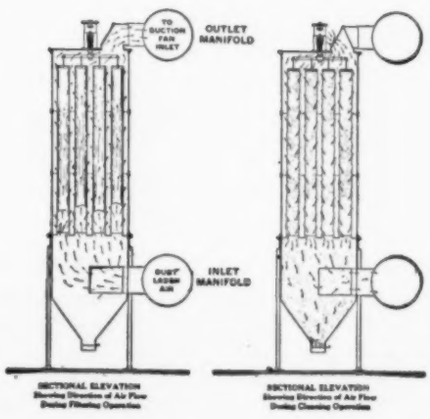

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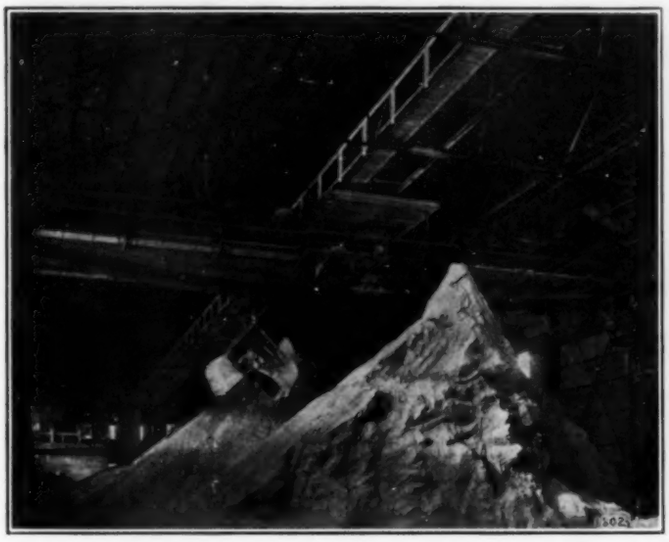

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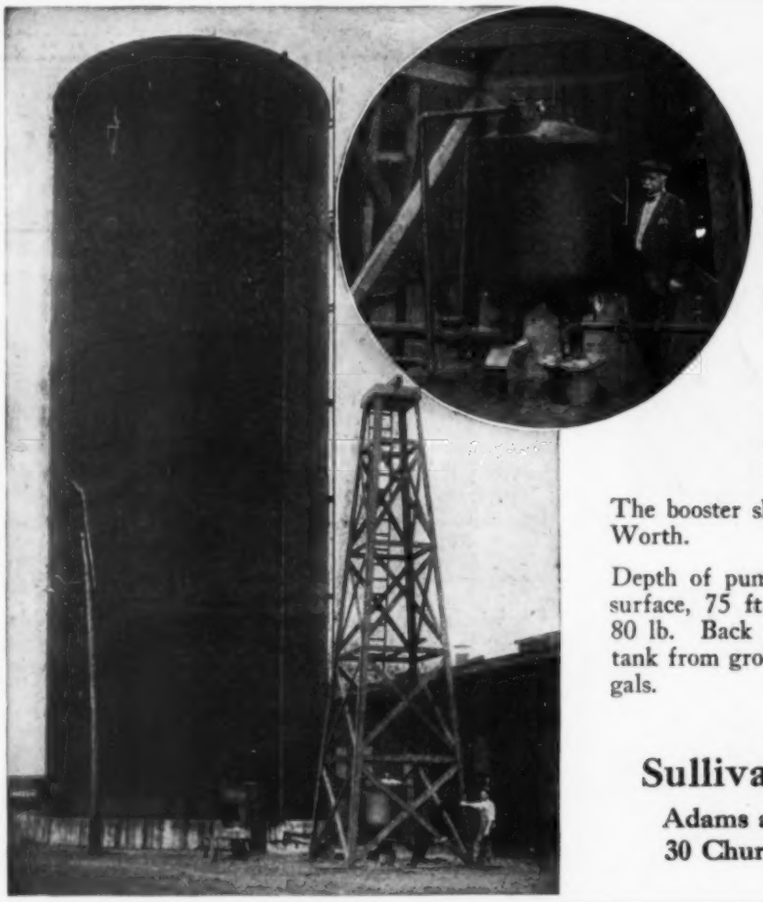

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(1) Pump water, acid, etc., horizontally or to an elevation by air power without installing separate pumps or gravity tanks.

(2) Use the same compressed air for this work that has already been used to lift water to the surface.

(3) System is entirely automatic.

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The booster shown is at the M. K. & T. shops at Fort Worth.

Depth of pump in well, 545 ft. Height of tank from surface, 75 ft. Air pressure to raise water to surface, 80 lb. Back pressure in booster to lift water to top of tank from ground, 10 lb. Flow of water per hour, 6000 gals.

Bulletin 71-DCM

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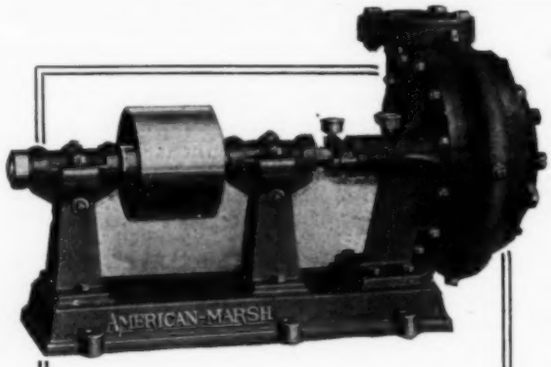

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The American-Marsh Line of Centrifugal Pumps is composed of both single and double suction types suitable for heads up to 250 feet.

They are equipped with wide ring oiled bearings and the single suction type has an overhanging casing enabling the discharge to be taken at any angle desired.

The runners are machined all over, insuring high efficiency.

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Ingersoll-Rand small compressors provide air power at low cost, not only on paper but in your shop. The little extra refinements in design and manufacture, about which we have been telling you in our advertising, *say nothing but save much* in actual compressor operation.

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423-C

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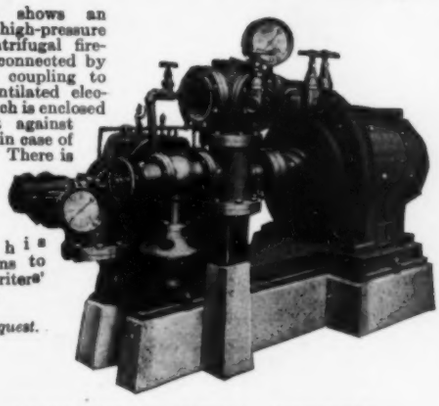
TRADE MARK REG. U.S. PAT. OFFICE.

CENTRIFUGAL AND DEEP WELL PLUNGER

PUMPS

A Dependable Fire Pump

Illustration shows an AMERICAN high-pressure two-stage centrifugal fire-pump, direct-connected by flexible shaft coupling to high speed ventilated electric motor which is enclosed to protect it against being deluged in case of hose rupture. There is also a safeguard against motor burning out from overload. This pump conforms to all underwriters' specifications.



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Gen. Offices and Wks. AURORA, ILL.

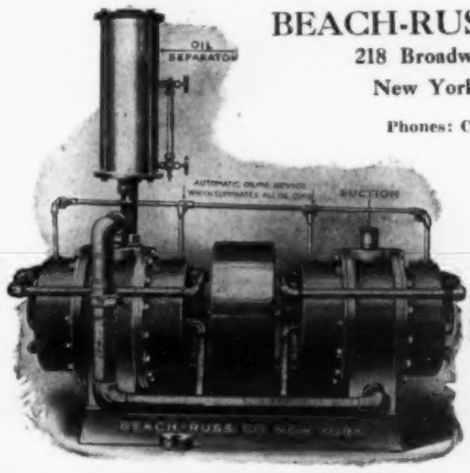
Chicago Office FIRST NATL. BANK BLDG.

It is the extreme simplicity of

Beach-Russ
Vacuum Pumps and
Positive Pressure Blowers

that renders their continuous service so efficient and economical, with less horsepower.

The vacuum pumps are guaranteed to exhaust within 1/10 in. of the barometer. The blowers give non-pulsating supply of air with regulation range between 1 and 12 lbs.



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218 Broadway

New York

Phones: Cortlandt 54, 55, 56

Acid Pumps
Filter Presses
Grinding
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Do You Transfer Liquids?

from one container to another? Empty barrels? or drums? Fill vessels? oil cans? or similar receptacles? Elevate? or convey liquids?

Then you need Rumsey Rotary Conveyors

Rumsey Rotary Transfer Conveyor handles oil, paint chemicals, glue, etc.—but no gritty liquids. Regularly in iron. Furnished in bronze for corrosive liquid. Complete with suction pipe, adjustable bung holder, hose coupling and tank hook. 2 sizes—13 and 25 gal. per minute.

Other manufacturers and distributors of chemicals, dyes, medicines, perfumes, extracts, soft drinks, oil products, ink, glue, varnish, etc., use them daily. Wouldn't be without them. Find they are economical workers of high efficiency.

The conveyor for emptying barrels or drums, transferring liquids, filling vessels, oil cans and for elevating or conveying liquids.

Several standard sizes; stocked in quantity, in iron; to order in bronze. Similar conveyors with tripod for portable use or with base and bracket for stationary floor or shelf mounting. Also supplied for belt or geared motor drive.

Put a Rumsey Rotary Conveyor on your pay-roll. Write for prices and bulletin DC-18.

Rumsey Pump Company, Ltd.

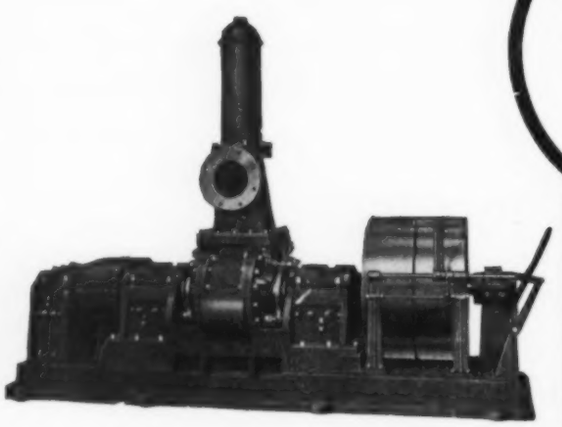
P. O. Box 383, Seneca Falls, New York

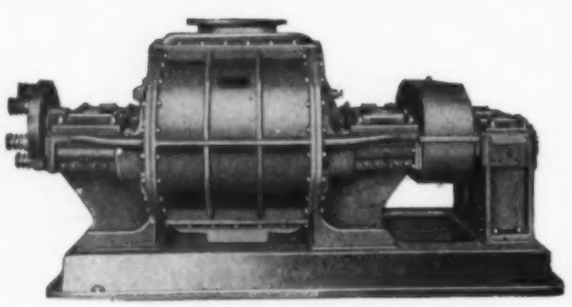
ROOTS

ROTARY POSITIVE BLOWERS
GAS EXHAUSTERS
PUMPS AND VACUUM PUMPS

FLEXIBLE COUPLINGS
BLAST GATES
RELIEF VALVES
FEED DEVICES
GOVERNORS

PRODUCTS





Blowers for agitating liquids, Flotation and Smelting Service

Gas Pumps for handling dry chlorine, sulphur dioxide or any non-corrosive gas.

Vacuum Pumps—wet and dry service up to 26 inches of mercury.

Rotary Pumps for handling any liquid for heads up to 200 feet. Gas Exhausters for By-Product Coke Ovens.

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Connersville, Indiana

Chicago: Peoples Gas Building

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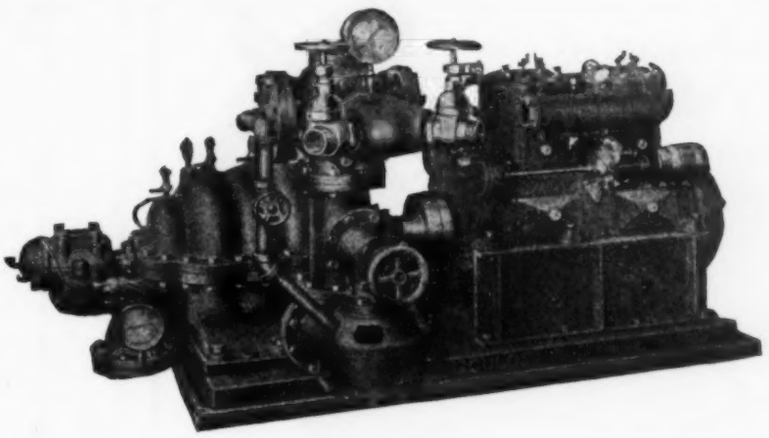
Pumping Outfits for "Stand-by" Service

In case your primary source of power fails, a GOULDS CENTRIFUGAL FIRE PUMP driven by a gasoline motor will give you an independent source of power for fire protection.



Goulds Fig. 3014 Centrifugal Pump direct connected to Sterling engine for "stand-by" service. Many Goulds outfits similar to this are in use in army cantonments, government buildings, etc., as emergency pumps.

Goulds Centrifugal Pumps

These outfits can also be furnished without the underwriters' fittings for general pumping services. They can be furnished with or without electric self-starters, as desired.

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A Mechanical Mixer of Air and Gas in Correct Proportions For Complete Combustions

Low Power Motor Constant Speed

Power Plant—Air Plant—Mixing Plant And Fuel Burner, All in One Unit

We Burn Oil Too

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Steel Strengthened, Acid Proof Wood Pipe

The Michigan Pipe Co., Bay City, Michigan

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All Kinds of Laboratory Apparatus and Supplies

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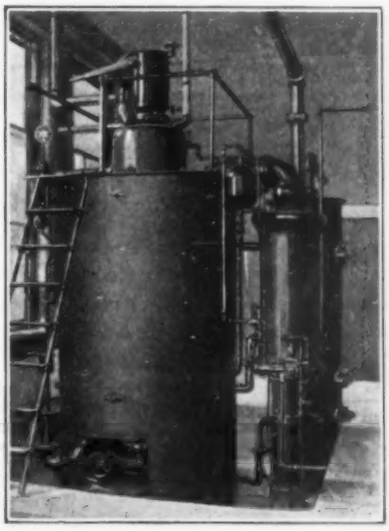
RELIANCE PRODUCTS

THE method by which steam is generated with the Sharp-Bassitt Combined Steam and Gas Generator is entirely a recovery process. In distilling the fuel, a certain percentage of the heating valve is thrown off through radiation, and this heat is used to generate steam—at no cost to the user.

The Sharp-Bassitt Generator is fully described in our latest Bulletin, which will be sent free, on request. Write today for a copy.



Milwaukee Reliance Boiler Works

Milwaukee, Wis.
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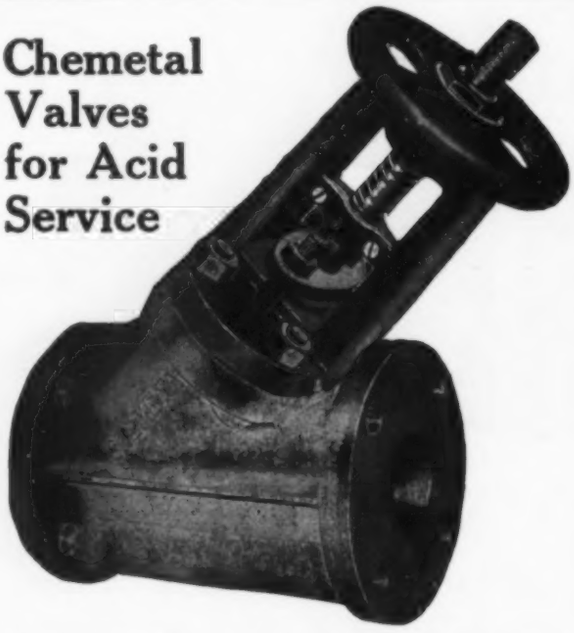
Chemetal Valves for Acid Service



Constructed to withstand the action of sulphuric acid, sulphurous acid, sulphate liquor and other corrosive liquids. Chemetal Valves can be furnished in standard sizes in the following patterns: Globe, Angle, "Y", Gate, and Diaphragm; also Vertical, Horizontal and Angle Check Valves.

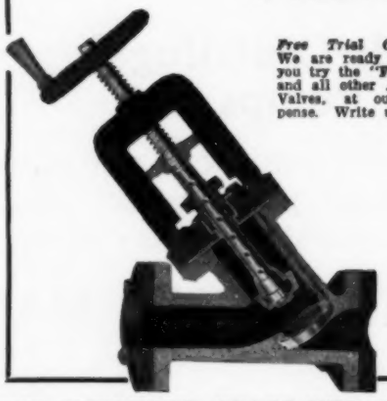
Consult us.

Nassau Valve and Pump Corporation
Rockville Center, Long Island, New York
Telephone, Rockville Center 1265

Do you handle heavy solutions?

If so, the "Freflo," the very latest development in Acimet Valves will prove a distinct advantage. Furnishes an absolutely unobstructed free flowing outlet to the liquid. All parts in contact with acid made of a special, unexcelled alloy—

Acimet Valves



Free Trial Offer—We are ready to let you try the "Freflo," and all other Acimet Valves, at our expense. Write us now.

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Sole Manufacturers
4612 Hamilton Ave. Cleveland, Ohio

BLAST GATE SUPERSEDES Gate Valves and Stop Cocks

(Patented)

"Better than gate valves for two reasons: 1st, cost; 2nd, easier operated." **Warner Chemical Works, Warner, N. H.**

For low and moderate pressures our New Air-Tight Blast Gate easily supersedes the heavy, cumbersome and slow-acting gate valves and stop cocks. Costs only a fraction of what you pay for gate valves and stop cocks and saves time and labor.

Write for Circular 123-H. It tells how our blast gate is made, how it works and what users think about it.

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CENTRIFUGAL
Pumping machinery for every kind of pumping service.

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THE KROGH The most widely used Sand Pump

Its special chilled car-wheel iron liners and moderate speed reduce costs and save trouble. Send for the Krogh Sand Pump Bulletin.

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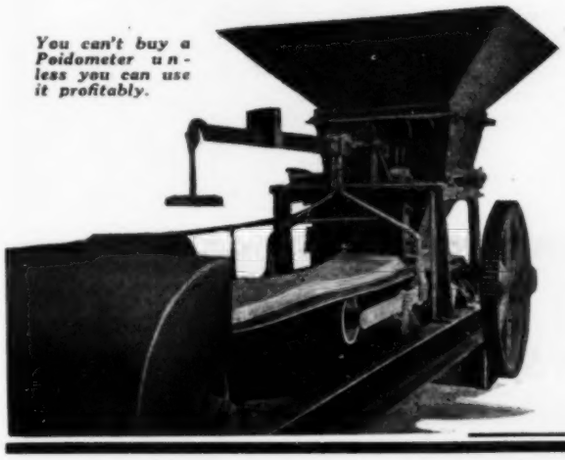
Weigh it with the Poidometer

You can't buy a Poidometer unless you can use it profitably.



SOLIDS or liquids. The Poidometer measures them proportioning one to the other with an accuracy of 99.5%. Entirely automatic. Few parts make it practically fool-proof.

The amount of material to be delivered is merely a matter of setting the weights on the scale beam to designated amount and putting machine in operation.

The Poidometer is successfully handling ores, clays, lime, limestone, oxide of zinc, white lead, coal. In one large installation a battery of Poidometers weigh and mix materials for a large grain and feed firm successfully producing the patent feeds that have made this company famous.

Write us for complete details and advise us of your problems

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The Genter Positive Thickener

(PATENTED)

For thickening dilute mixtures where the solid content is from 0.5% to 5%.

Especially adapted for use in sugar factories, chemical plants, municipal water supplies, etc.

Advance bulletin descriptive of the Genter Thickener will be mailed upon request.

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Globe Pattern—Plug and Seat Type.
Lead, Tin, Brass or Copper-lined Iron Pipe.
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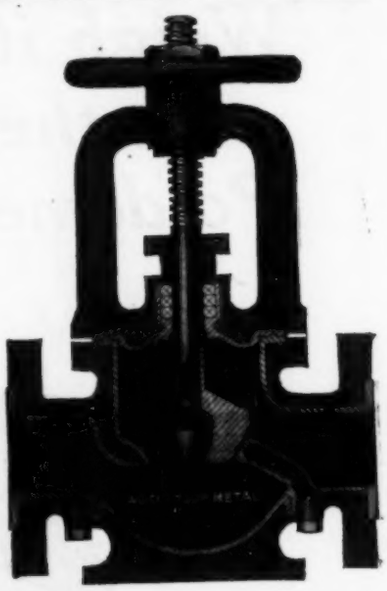
"United" Acid Proof Valves



COMBINE strength of heavy cast iron valves with the acid-resisting qualities of solid lead valves.

Simple and durable in design. Easy to take apart and repair.

Made in all required sizes and styles: Globe, gate Angle, "Y" Pattern or Free Flow Type, and Diaphragm Valve.

Valves may be heavily lined with pure block tin for handling acetic acid, citric acid, etc.

United Acid Valves are being used with great success in the chemical, paper and dye industries.

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UNITED LINED TUBE & VALVE CO.
Manufacturers Boston, Mass.

The "PROCTOR" Drying Machine (Truck Tray Type), for Chemicals and similar materials.

Drying and Success

The success of any business depends upon three fundamentals:

Quality of the product
Capacity of the plant
Cost of production

All three are decidedly affected by the drying system being used.

The "Proctor" Dryer is guaranteed to increase the plant output of highest quality products at the least cost.

The Philadelphia Textile Machinery Co.
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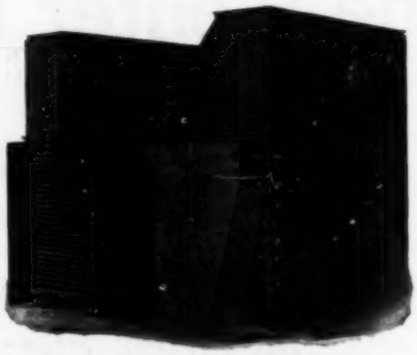
Hamilton, Ont., Can., W. J. Westaway, Main and McNab Sts.

"HURRICANE" DRYERS



"Hurricane" Truck Dryer with Trays

"Hurricane" Dryers are fire-proof, safe and economical, and are built in many standard sizes for:

Chemicals, Pigments, Dyes, Leather Board, Asbestos Mill Board, Cotton, Linters, Wool, Hair, Rags, Yarn, Cloth, and all kinds of Textiles. Sugar and Nitrate of Soda Bags.

Special Dryers to suit special requirements.

Write for full information. State material and details.

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Direct Motor Driven

BEING absolutely self-contained, the "Hercules" (electric-drive) Hydro Extractor may be installed in the most advantageous place—leaving steam pipes or shafts entirely out of account. Into its construction have gone the best ideas of plant superintendents and centrifugal engineers.

To cite but a single Hercules feature:—A special automatic clutch connects motor and extractor. A push button starts motor up without any further attention and without the need of complicated starting apparatus. The motor thus starts under no load and the clutch shoes flying out by centrifugal force giving a remarkably smooth and even acceleration to the extractor basket.

The "Hercules" costs no more than the belted type—yet operation annoyance is reduced to minimum. Details on request.

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Diameter Basket	Depth Basket	Normal R P M	Cu. ft. Basket Capacity Full	Size Motor
30	14	1000	5	3 H. P.
36	14	900	8	4 H. P.
42	18	800	13	5 H. P.
48	18	700	18	7½ H. P.

GILLESPIE MOTOR CO. — SUCCESSORS TO — PATERSON N.J. AMERICAN SHELL CO.

Scientifically Self-Balanced—

that expresses it—the word *scientific* as applied to the manner of design and operation of the Self-Balancing feature of the

TOLHURST CENTRIFUGALS

This Self-Balancing feature permits safer handling of unbalanced loads at high speed. Gravity is the controlling factor — no springs, rubber cushions or other complicated devices being employed.

Tolhurst Centrifugals are unapproached for continuous and exacting service. They are recognized as the standard of efficiency and durability for all classes of chemical work.

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Write now and outline your requirements. We may be able to make some practical, money-saving suggestions. No obligation.

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Since 1828

If you will use some of our

ACID RESISTING ENAMELED WARE

for a while you will realize that Dr. Emerson was exactly right in his remark about the relationship between publicity and the superlative quality applied to even an humble mouse trap.

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Fifty years producing Cast Iron Ware with Enamel lining.

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GRAIG FOUNDRY CO.
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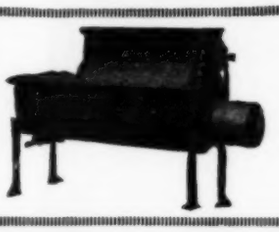

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Sifters and Mixers
The "Gardner" Line of Mixing Machinery Can Be Depended Upon to Produce Results.
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A liquid integral hardener. Makes concrete dustless and waterproof. Used successfully for fifteen years. Write for details.
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ELMORE **Acid-Proof Centrifugal Pumps**

Volute made of chemical stoneware. Impeller and stuffing box acid-proof
Strong construction, built for continuous operation.
Sizes: 1 to 3-in. discharge.

Write for full information, prices and guarantee.

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"Neither rusts, stains nor tarnishes"

Has a distinct advantage over nickel steels containing a high percentage of nickel in that Stainless Steel can be readily softened for machining purposes, and can be suitably hardened afterward.

Especially adaptable for CUTLERY, ROLLER BEARINGS, MACHINE and ENGINE PARTS, TOOLS, DIES, or other articles subjected to the effects of steam, acids, fog, water or heat.

Can be supplied in all standard sizes of round, square or flat bar steel. Also made in a few sheet and strip sizes.

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Rapid and Easy in Operation
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"JASCO WARE" OF SEAMLESS STEEL

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Simple *Economical* *Efficient*

Resines Super-Filters

No Choking
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Our Chemical Laboratory

is well equipped to help you with your *Process Problems.*

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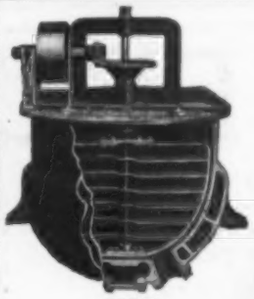
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Superiority of Dopp design and construction contribute to the improvement of products and the reduction of manufacturing costs.

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Autoclaves *Extractors*
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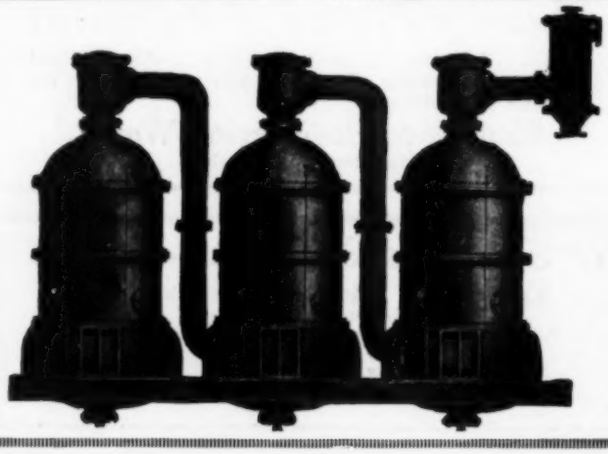
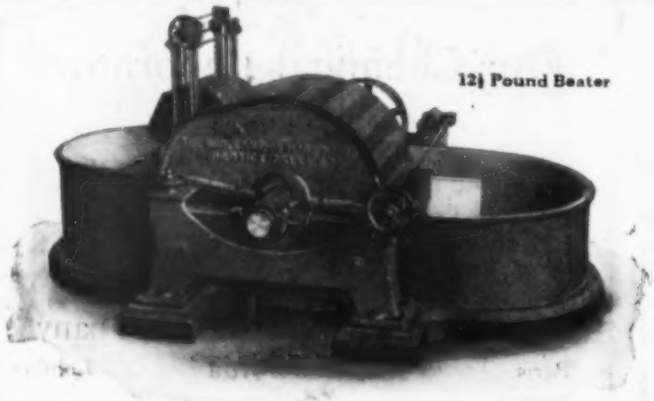
Est. 1870 in Phila.

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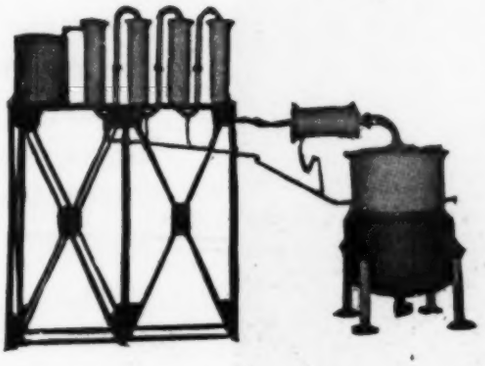

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If They Are in Excess in Solids, Evaporate and Then Condense Them

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Either type of apparatus, or both, can be supplied to you by us, promptly.

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Exactness of skilled workmanship—ample thicknesses of metal and other features assuring dependable operation, evident in the autoclaves shown here, are characteristics of all Valleiron equipment.

Our standard line is most complete. We make special apparatus to requirements.

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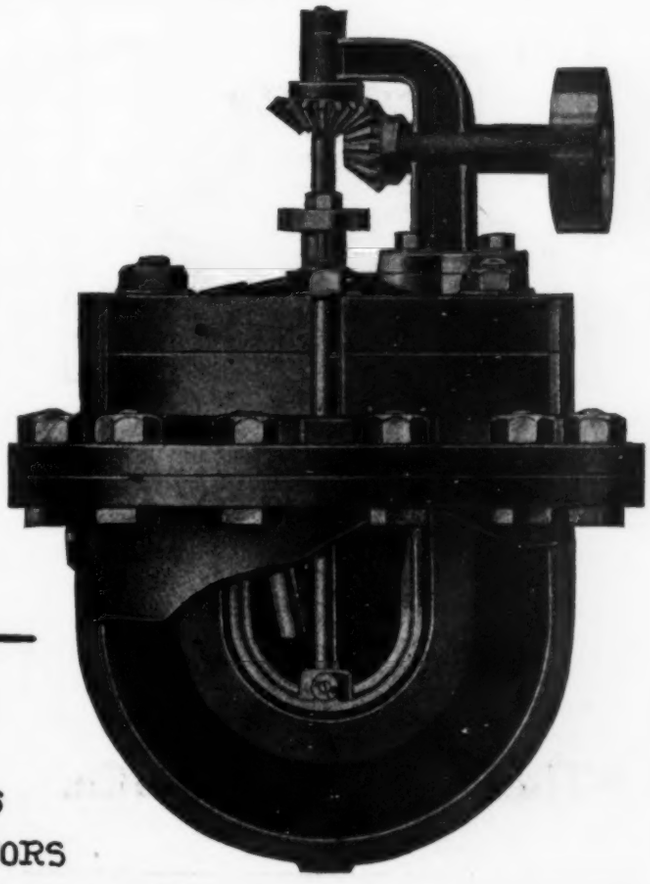

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During the past 75 years we have designed and built practically every type of chemical apparatus. Today thousands of users the world over know the high degree of "S & P" quality. Any average need quickly filled from our great stock of patterns—at a very appreciable saving. Large, complete catalog on request.

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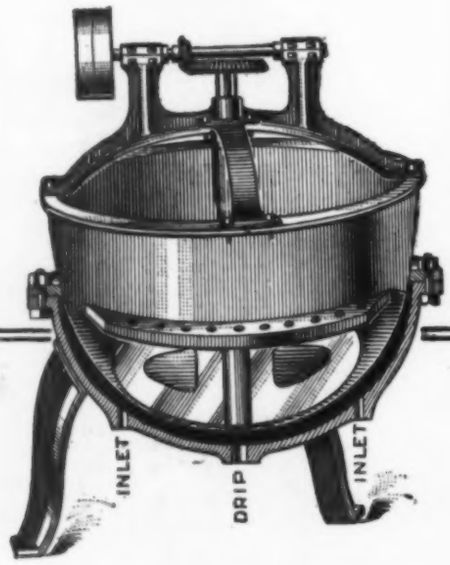

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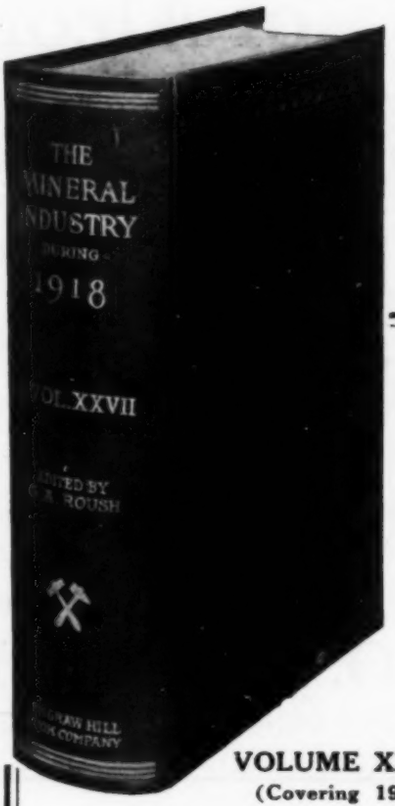

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Mineral Industry is international in character. It gives sources of supply and statistics of production for the various countries of the world, and discusses markets and commercial possibilities.

VOLUME XXVII
(Covering 1918)

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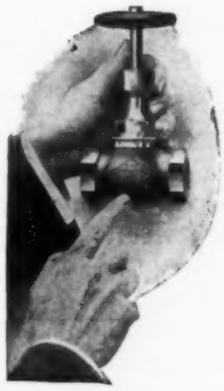

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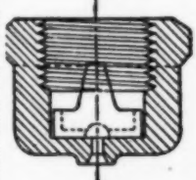

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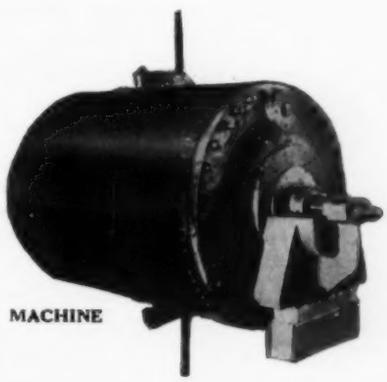

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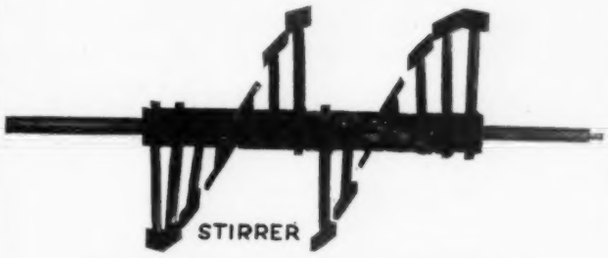

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It Empties Itself

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Dimensions

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Floor space required.....3 x 4 ft.
Capacity, each cylinder..... 4 gal.
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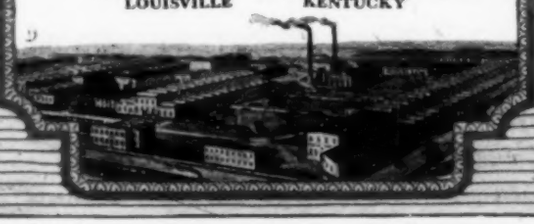

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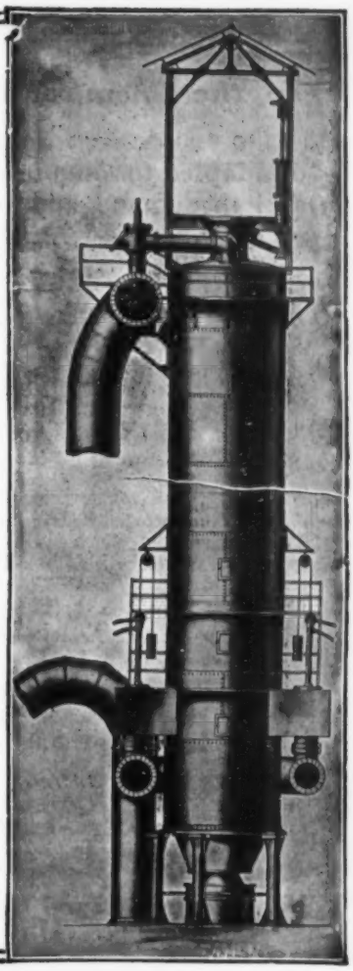

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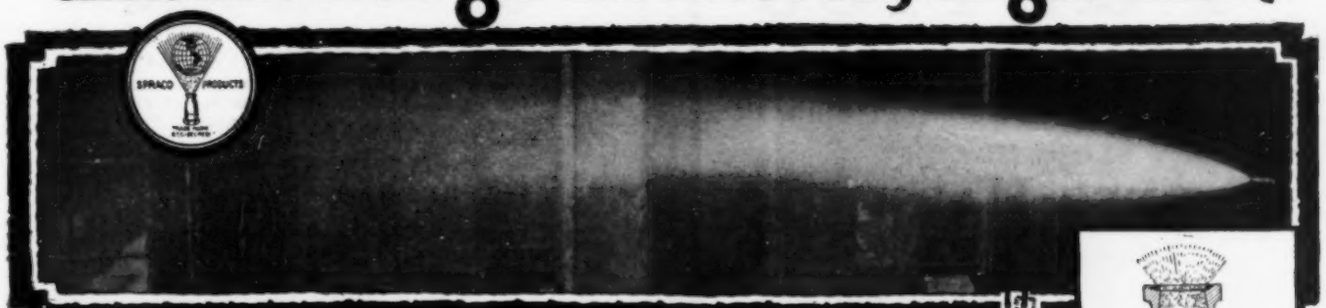
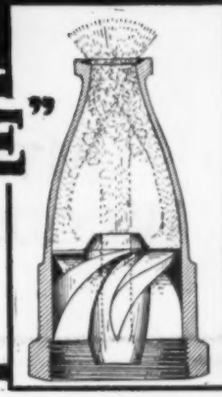
For mixing of oil and steam in gas manufacture, also mixing of naptha and natural gas for recovery of gasoline.



"SPRACO 2 FLUID NOZZLE"



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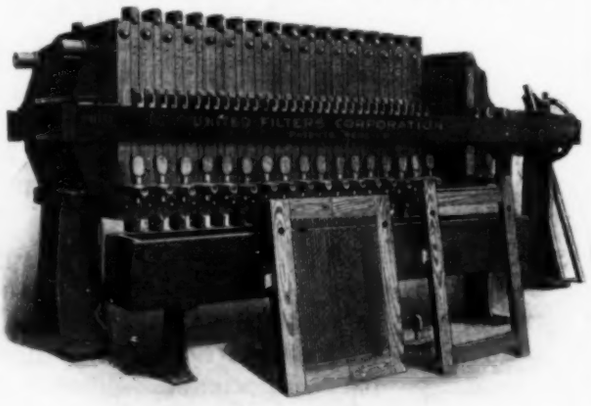

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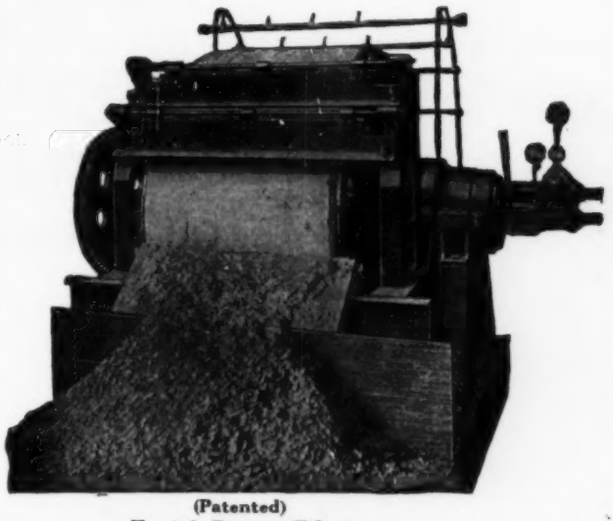

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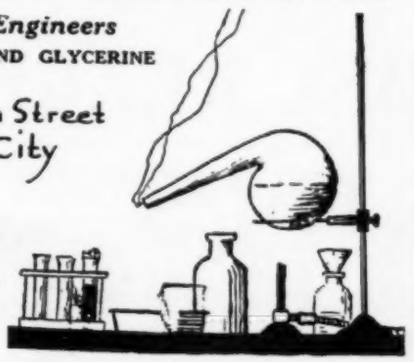

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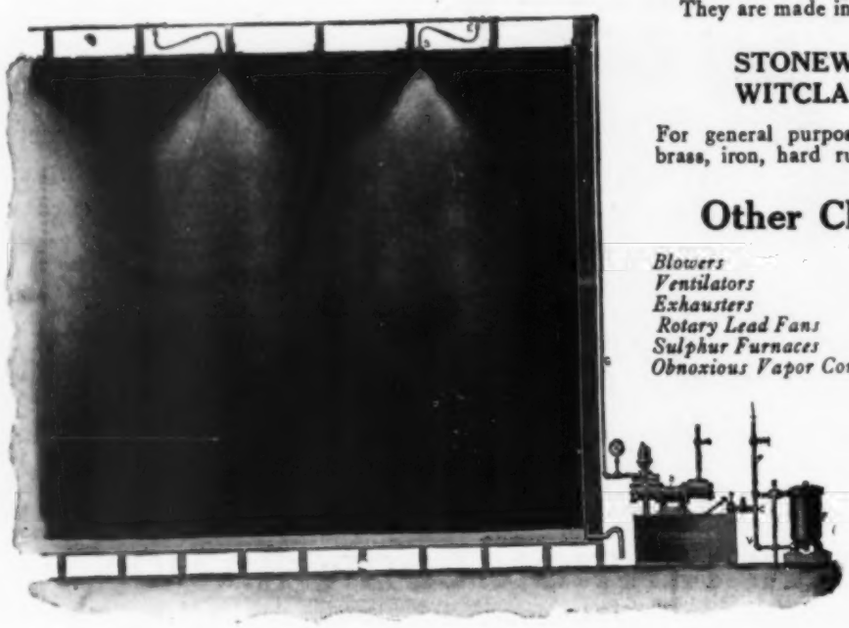
S. & K. Acid Chamber Spray Nozzles increase production



Control temperature and regulate operation.
They are made in

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For the purification of water.
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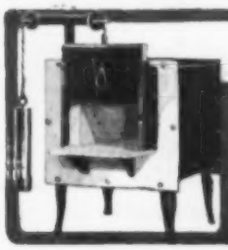
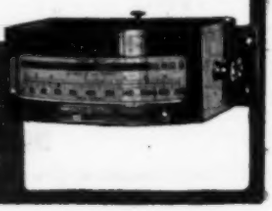


HOSKINS
ELECTRIC FURNACES - PYROMETERS



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Ball Thrust Agitator Drive

No. 0 No. 1 No. 1½ No. 2

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Size	Pinion Shaft	Gear Shaft	Gear		Pinion		T and L Pulleys	Length Over All
			P. Diam.	Face	P. Diam.	Face		
No. 0	15/16"	1 3/16"	8"	1¼"	2"	1¼"	8" x 3"	1' 11"
No. 1	1 3/16"	1 15/16"	13.37"	2"	3.34"	2"	12" x 4"	2' 9"
No. 1½	1 3/16"	1 15/16"	16"	2½"	4"	2½"	12" x 4"	3' 2"
No. 2	1 15/16"	2 7/16"	23.87"	3"	5.97"	3"	18" x 5"	4' 2"

Four Sizes: Each equipped with Belt Shifter and Gear Guard. Immediate Shipment.

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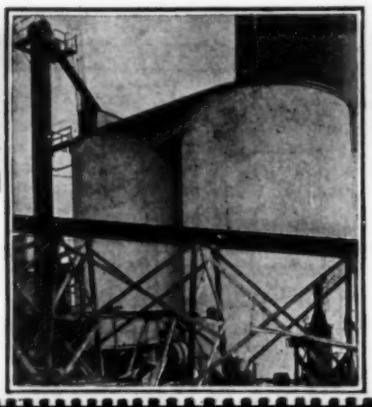
(BOSTON POSTAL DISTRICT)
Manufacturers of Wood Tanks and Related Appliances for the Chemical Industries



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Reinforced concrete storage bins and tanks for bulk and liquid materials.

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Try Redwood for Acid and Alkaline Solutions
Prompt deliveries of any size or shape.
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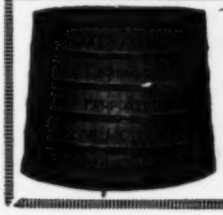
TANKS
OF FIR, CYPRESS and REDWOOD
Prompt Deliveries—Send us your specifications
J. Rosenwach, 617-625 Grand St., New York



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Stay Watertight Indefinitely
A. J. CORCORAN, Inc.
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Over 50 years' experience serving Metal, Oil, Chemical and allied industries.

Sharpsville Boiler Works Co.
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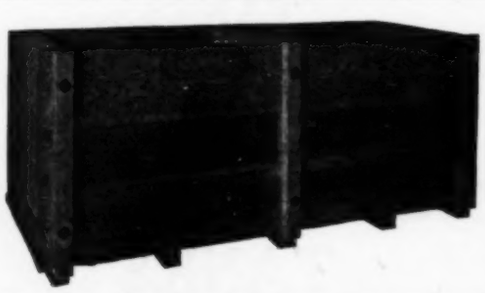

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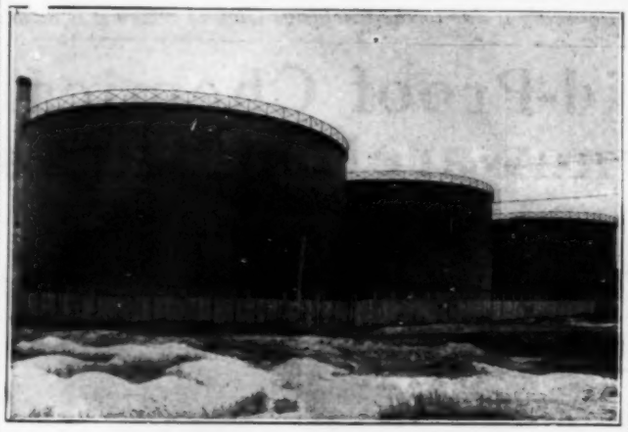

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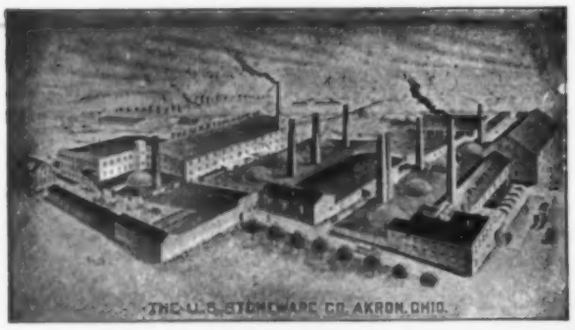

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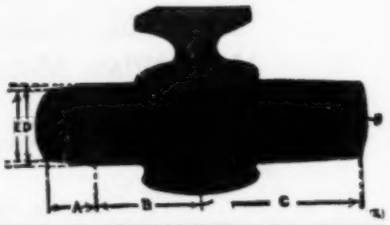

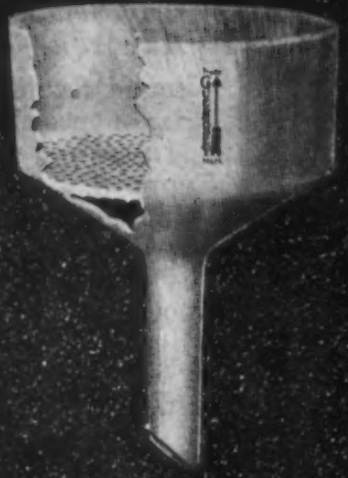

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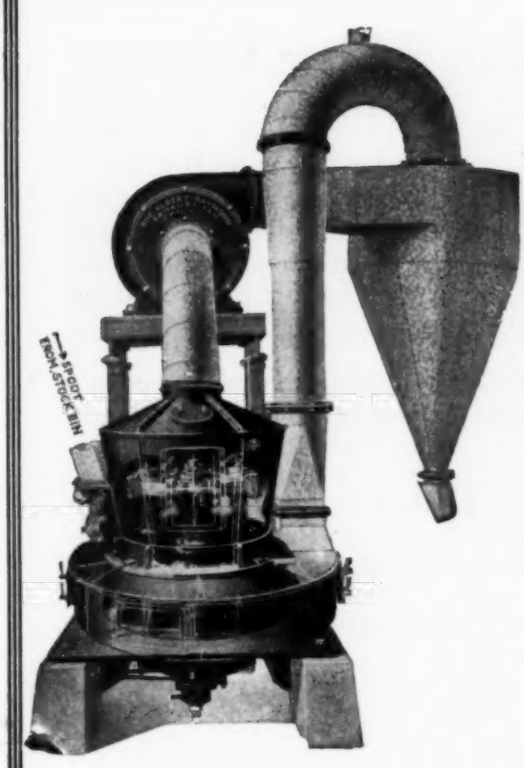

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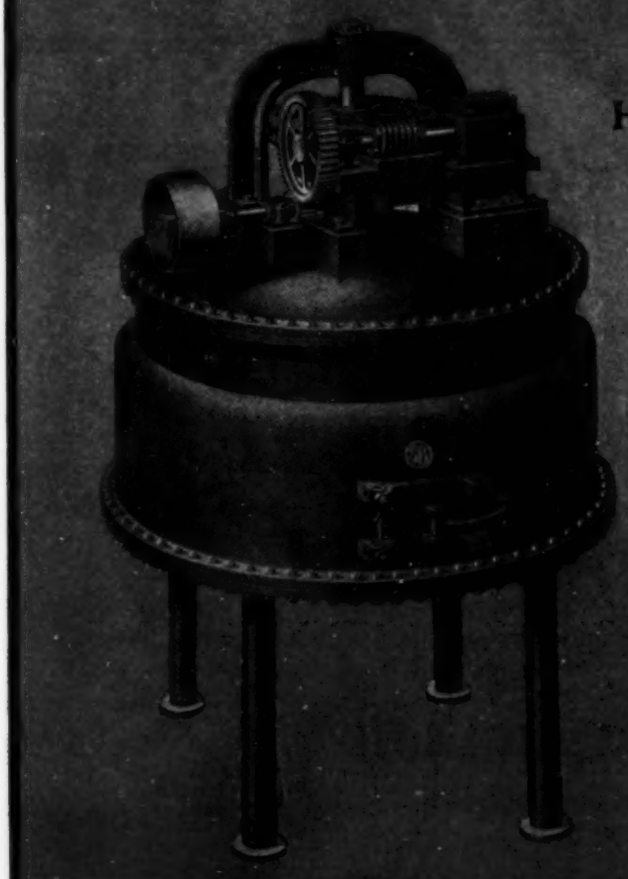

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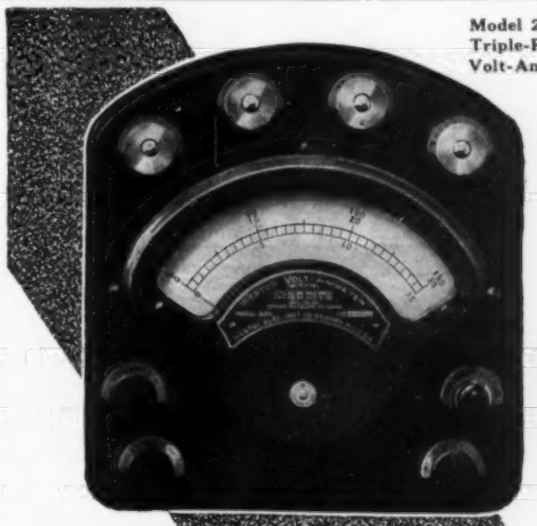

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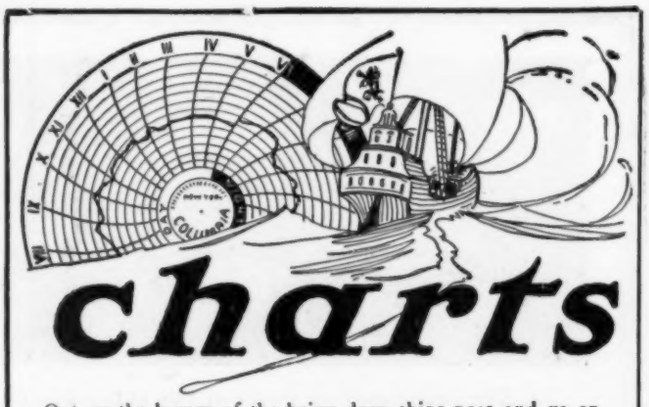

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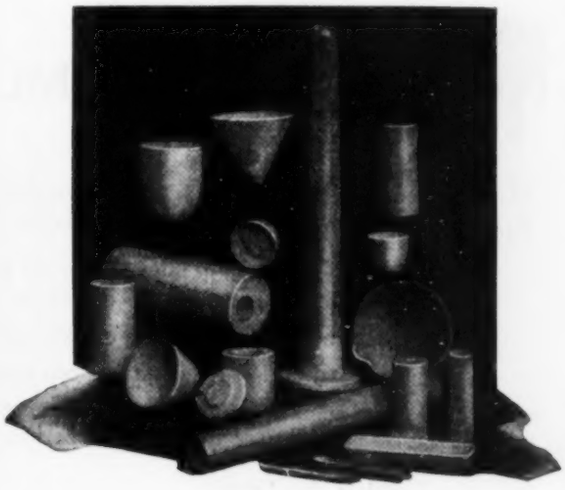

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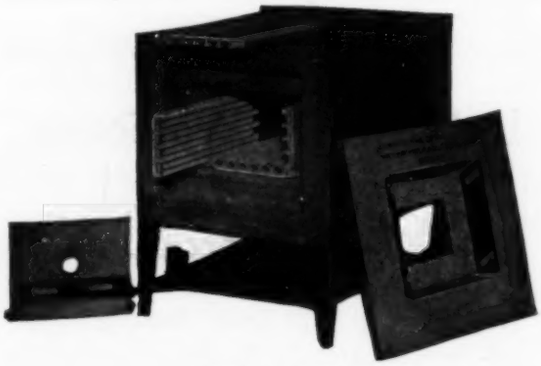

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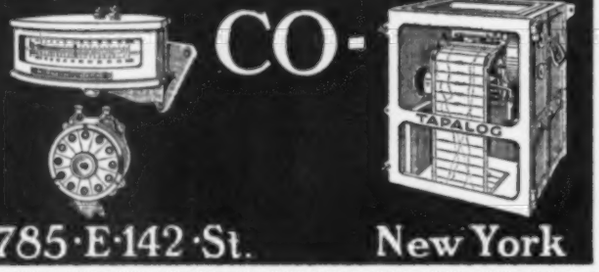

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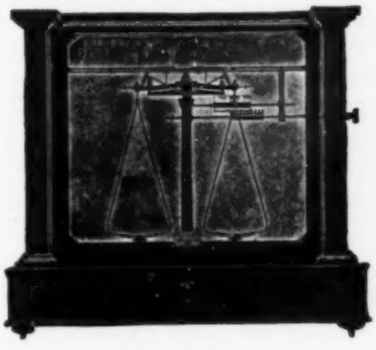

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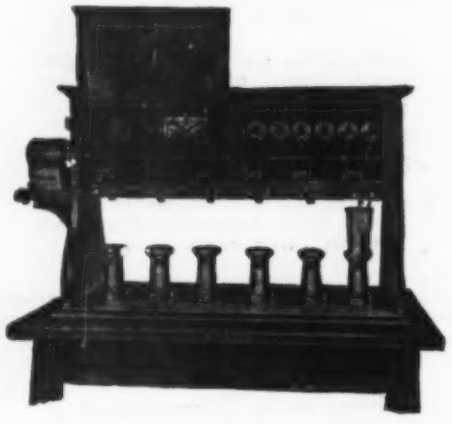
The Braun Electrolytic Outfit

With Revolving Anodes



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Circular S-101

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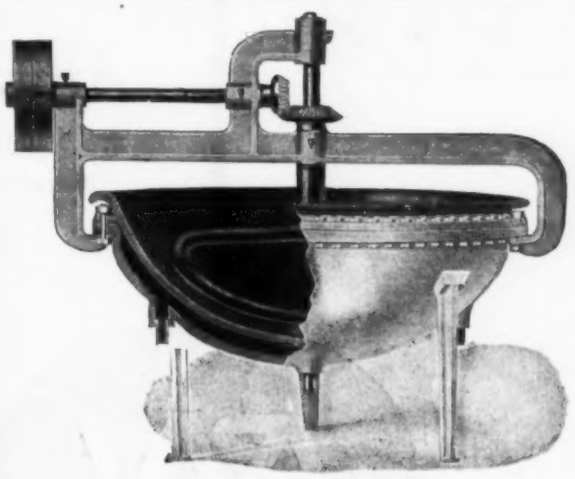

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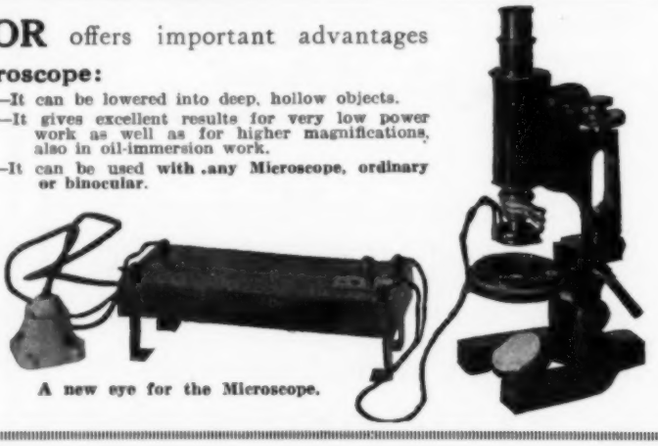

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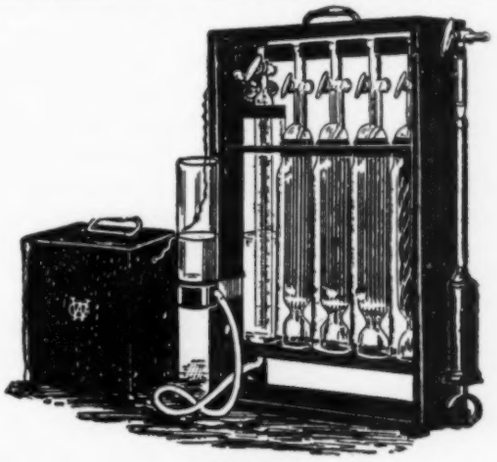

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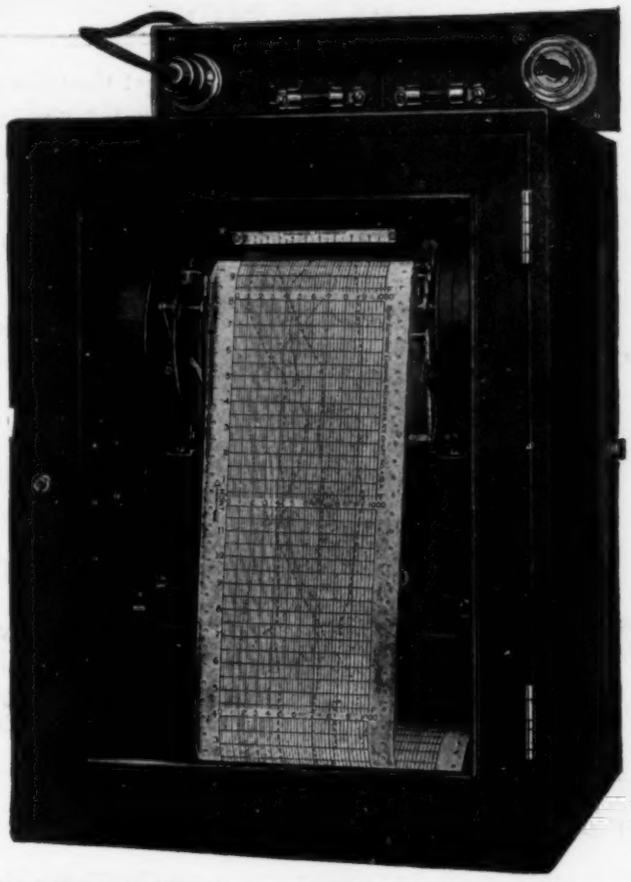

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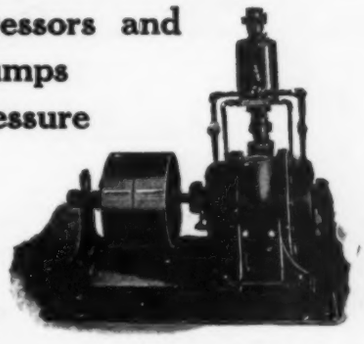

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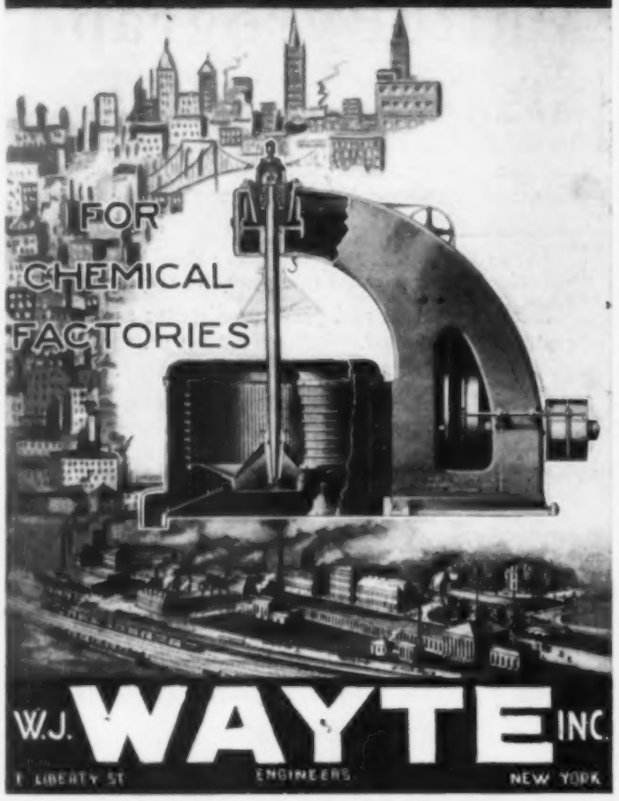

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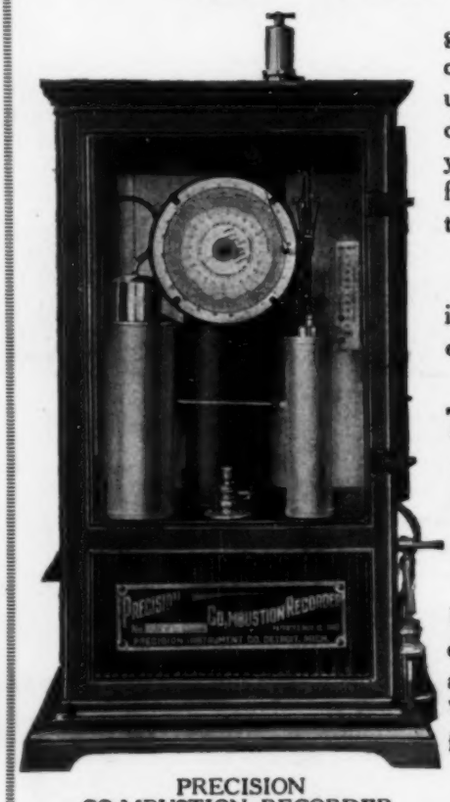

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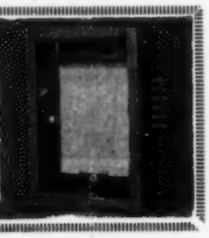

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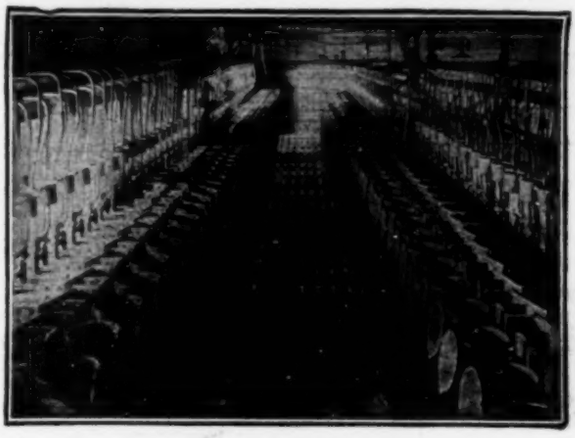

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MOTORS—2-PHASE, 60-CYCLE, 220-VOLT

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1	10	Westg.	HF	1200	U Stock
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2	40	All.-Chal.	AN	1200	N Stock
2	40	All.-Chal.	ANY	900	N Stock
2	50	All.-Chal.	AN	720	N Stock
1	50	All.-Chal.	AN	1200	N Stock
1	50	All.-Chal.	ANY	900	N Stock
1	75	All.-Chal.	AN	900	N Stock
1	75	All.-Chal.	ANY	720	N Stock

MOTORS—3-PHASE, 60-CYCLE, 2220-VOLT

No.	Hp.	Make	Type	R.p.m.	Avail.
1	100	Westg.	CW	900	N Stock
1	150	W. E.	M	600	N Stock
2	150	Westg.	CW	600	N Stock

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1	150	Westg.	HF	600	U Stock
1	150	W. E.	M	600	N Stock
2	150	Westg.	CW	600	N Stock

MOTORS—2-PHASE, 25-CYCLE, 225-VOLT

No.	Hp.	Make	Type	R.p.m.	Avail.
1	50	Westg.	CCL 3 Brg.	250	U Stock
1	50	Westg.	HF	250	U Stock
2	50	Westg.	CW	250	N Stock

MOTORS—3-PHASE, 25-CYCLE, 220- and 440-VOLT

No.	Hp.	Make	Type	R.p.m.	Avail.
1	50	Westg.	CS	750	U Stock
3	50	All.-Chal.	AN	750	N Stock
6	50	W. E.	KT	750	N Stock
1	50	Westg.	HF	250	U Stock
2	50	Westg.	CW	250	N Stock

MOTORS—3-PHASE, 25-CYCLE, 550-VOLT

No.	Hp.	Make	Type	R.p.m.	Avail.
1	50	Westg.	CCL 3 Brg.	214	U Stock
1	50	Westg.	HF	250	U Stock
2	50	Westg.	CW	250	N Stock

MOTORS—110-VOLT D.C.

No.	Hp.	Make	Type	R.p.m.	Avail.
1	10	Ft. Wayne	Bl	400	U Rented
1	10	Westg.	S	650	U Stock
1	15	R. & M.	Cpd.	1050	U Stock
2	15	Westg.	SK Sh	1250	U Stock
1	15	Eddy	G Sh	900	U Stock
1	15	Wood	L. B.	230	U Stock

WRITE WIRE PHONE

No.	Hp.	Make	Type	R.p.m.	Avail.
1	20	G. E.	CVC Sh	1720	U Stock
1	20	Holt Cab.	MP Sh	700	U Stock

MOTORS—220-VOLT, D.C.

No.	Hp.	Make	Type	R.p.m.	Avail.
1	10	Westgh.	M Sh	1250	U Stock
1	12½	Otis	Elev. Cpd.	800	U Stock
1	15	G. E.	CE Sh	1100	U Stock
1	20	Ft. Wayne	Elev. Cpd.	820	U Stock
1	20	Westg.	S Sh	1300	U Stock

MOTORS—550-VOLT D.C.

No.	Hp.	Make	Type	R.p.m.	Avail.
1	10	G. E.	CE	800	U Stock

GENERATORS D.C.

No.	Kw.	Make	Type	Volts	R.p.m.	Avail.
1	¼	Westg.	R	125	2100	U Stock
1	¼	Phoenix	L	110	525	U Stock
1	¼	G. E.	CQ	110	1100	U Stock
1	1	Diehl	G	125	1400	U Stock
1	1.8	F. M.	TR	115	2350	U Stock
1	1½	Phoenix	L	110	1050	U Stock
1	1½	W. E.	DF	110	975	U Rented
1	1½	G. E.	CQ	110	2200	U Stock

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No.	Kw.	Make	Type	St. Pres. lb.	Avail.
2	1½	Pyle	Marine	125	N Stock
2	3	Pyle	Marine	125	N Stock

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1—Laidlaw-Dunn-Gordon, cross compound 12 x 18; 14 x 12; 700 cfm, 80 lb. air; steam driven.

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1—Louisville steam-heated, 54 in. dia., 25 ft. long, steam tubes
1—Ruggles-Coles Hot Air, type W-1, 36 in. dia., 20 ft. long, steam coils, blower.
1—Ord Fertilizer Dryer, 72 in. inside dia., steam jacketed with stirrer.
1—Stokes Rotary Vacuum, 36 in. dia., 15 ft. long, barometric condenser, vacuum pump, complete.
1—Buffalo Rotary Vacuum, 36 in. dia., 15 ft. long, surface condenser, vacuum pump, complete.
1—Direct Heat Rotary, 36 in. dia., 30 ft. long, stack, furnace castings, complete.

FILTER PRESSES,
1—Shriver, 24 x 24, iron, 18-1 in. chambers, open delivery, washing.
1—Kelly, type 150, 9 leaves.
1—Sperry, 30 in. x 30 in., wood, 13-2 in. chambers, open delivery.
1—Industrial Continuous Filter, 6 ft. dia., 5 ft. face.

KETTLES, steam jacketed,
2—Cast iron kettles, 250 gals., steam-jacketed, open top.

LABELING MACHINE,
1—Burt Labeler, for ½ pt., pt., and quart cans, motor-driven.

MILL,
1—Fuller, 33 in.

MILL, tube,
1—West, 44 in. dia., 25 ft. long, silex lining, automatic feed, pebbles.

MIXERS,
8—Werner & Pfleiderer, Type V, size 12, 20 gal., self dumping, steam jacket.
3—Day, 40 gal., steam jacketed, bottom discharge.
12—Day, 30 gal., bottom discharge.
1—Werner & Pfleiderer Masticator, Type IV, size 12, 50 gals.

PUMPS,
3—Goulds Three-Stage Centrifugals, 5 in. suction and discharge, 650 gals. per minute, 1720 R.P.M., 175 lb. working pressure, direct connected to 50 H.P. electric motor.
1—Goulds Three-Stage Centrifugal, 5 in. suction and discharge, 500 gals. per minute, 1440 R.P.M., 175 lb. working pressure, belt-driven.
1—Gould Single-Stage, double suction centrifugal, 5 in. suction, 4 in. discharge, 650 gals. per minute, 1720 R.P.M., direct connected to electric motor.
6—Goulds Rotary, 4 in. suction, 2 in. discharge, belt-driven, 50 to 100 gals. per minute.
1—Lawrence, two-stage Centrifugal, 10 gals per minute, 50 lb. pressure, bronze fitted, belt driven.

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2—1500 gal., 56 in. dia., 12 ft. long, 5-16 in. plate.
1—1300 gal., 36 in. dia., 25 ft. long, 3-8 in. plate.
3—3000 gal., 5 ft. dia., 20 ft. long, ¼ in. plate.

TANKS, horizontal weighing,
2—2400 gal., 6 ft. dia., 11 ft. 6 in. long, ¼ in. plate, mounted on 20,000 lbs. capacity Howe scale.

TANK, glass enameled,
1—300 gal., 42 in. inside dia., 48 in. long, steam jacketed.

TANKS, digesting,
2—2200 gals, 6 ft. dia., 10 ft. 6 in. high overall, ¼ in. plate, cone bottom, 3 ft. 3 in. long, charging door on top, discharge door at bottom.

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Denver Fire Clay Co.
Guernsey Earthenware Co.
Mine & Smelter Supply Co., The
Scientific Materials Co.

Crushers, Grinders and Pulverizers
See Machinery, Crushing, Grinding and Pulverizing

Crystallizing Dishes and Pans, Stoneware
See Stoneware, Chemical

Crystallizing Pans, Cast Iron
Buffalo Foundry & Machine Co.
Devine Co., J. P.
Pfaudler Company

Cupels
Dixon, Jos., Crucible Co.

Curb Boxes, Meter
Cast Iron Pipe Publicity Bureau

Cyanide Machinery
See Machinery, Cyanide

Cylinders, Steel
Janney-Steinmetz Co.

Derricks
Insley Manufacturing Co.

Die Castings (Bronze)
Titanium Alloy Mfg. Co., The

Diffusion Batteries
Blair, Campbell & McLean, Inc.
Lummus Co., The Walter E.

Digesters
Blaw-Knox Co.
Elyria Enameled Products Co.
Glass Coating Co.
Manitowoc Engineering Works
Stuart & Peterson Co.
Swenson Evaporator Co.

Disintegrators
Jeffrey Manufacturing Co., The

Dissolving Machines
Lummus, The Walter E., Co.

Distilling Machinery & Apparatus
Badger, E. B., & Sons Co.
Blair, Campbell & McLean, Inc.
Buffalo Foundry & Machine Co.
Detroit Heating & Lighting Co.
Devine Co., J. P.
Duriron Casting Co.
Eimer & Amend
Elyria Enameled Products Co.
Glass Coating Co.
Isbell-Porter Co.
Koven, L. O., & Bro.
Lummus, The Walter E., Co.
Mott, J. L., Iron Works
Oakland Copper & Brass Works
Ott, Geo. F., Co.
Pfaudler Company
Scientific Materials Co.
Scott, Ernest & Co.
Sowers Mfg. Co.
Stevens-Aylsworth Co.
Stokes Machine Co., F. J.
Stuart & Peterson Co.
Swenson Evaporator Co.
Zaremba Co.

Doors, Chain Screen
Codd, E. J., Co.

Downspouts
Robertson Co., H. H.

Drives, Silent Chain
Link-Belt Co.

Drop Forge Fittings
Vogt, Henry, Machine Co.

Drums, Steel
Detroit Range Boiler and Steel Barrel Co.
Devine Co., J. P.

Dry Blast Plants
Carrier Engineering Corporation

Dry Cell Filler
Acheson Graphite Co.

Dryers, Centrifugal
Elmore, G. H.
Fletcher Works
Gillespie Motor Co.
Tolhurst Machine Works
U. S. & Cuban Allied Eng. Wks. Co.

Dryers, Vacuum
Buffalo Foundry & Machine Co.
Devine Co., J. P.
Jacoby, Henry E.
Scott, Ernest & Co.
Stokes Machine Co., F. J.

Drying Mach. and Apparatus
American Blower Co.
American Process Co.
Bartlett & Snow, The C. O., Co.
Bay City Iron Company
Buckeye Dryer Co.
Buffalo Forge Co.
Buffalo Fdry. & Mach. Co.
Buffalo Steam Pump Co.
Christie, L. R.
Devine Co., J. P.
Fleisher, W. L. & Co., Inc.
Fuller-Lehigh Co.

Gordon Dryer Corp'n.
Kalpberry Corporation
Koven, L. O., & Bro.
Manitowoc Engineering Works
Philadelphia Drying Mach. Co.
Philadelphia Textile Mach. Co.
Ruggles-Coles Engineering Co.
Scott, Ernest & Co.
Stokes Machine Co., F. J.
Swenson Evaporator Co.
Vulcan Iron Works

Ducts, Ventilating
Robertson Co., H. H.

Duriron
Duriron Castings Co.

Dust Collecting Systems and Engineers
Dust Recovering & Conveying Co.
Northern Blower Co.
Pratt Eng. & Machine Co.
Raymond Bros. Imp. Pul. Co.

Dynamos, Electroplating
See Electroplating Dynamos, Supplies

Dynamos and Motors
General Electric Co.
Jantz & Leist Elect. Co.
Westinghouse Electric & Mfg. Co.

Electric Furnace Cores, Alumidum
Norton Co.

Electrical Supplies
General Electric Co.

Electric Testing Sets
American Transformer Co.
Thordarson Electric Mfg. Co.
Weston Electric Instrument Co.

Electrodes, Carbon
Acheson Graphite Co.
National Carbon Co.
Republic Carbon Co.
Speer Carbon Co.
Stackpole Carbon Co.

Electrodes, Graphite
Acheson Graphite Co.

Electrolytic Cells
Electrolabs, Inc.
Electron Chemical Co., The
International Oxygen Co.
Warner Chemical Co.

Electrolytic Oxygen & Hydrogen Generators
Electrolabs, Inc.
International Oxygen Co.

Electroplating Dynamos; Supplies
Eager Electric Co.
Jantz & Leist Electric Co.

Electroplating Salts
Roessler & Hasslacher Chem. Co.

Enameled Apparatus, Acid Resisting
Elyria Enameled Products Co.
Glass Coating Co.
Plaudler Company, The
Stuart & Peterson Co.

Engineers, Chemical, Consulting, Analytical, Industrial
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American Industrial Eng. Co.
Austin Co., The
Booth Electric Furnace Co.
Dust Recovering & Conveying Co.
Filtration Engineers, Inc.
Fleisher, W. L., & Co.
Garrigue & Co., Wm.
General Engineering Co.
General Machine Co.
Guarantee Construction Co.
Pratt Eng. & Machine Co.
Pulverized Fuel Equipment Corp.
Uehling Instrument Co.

Engineers, Combustion
Foxboro Co., The
Garrigue, Wm. & Co.
Improved Equipment Co.
Pulverized Fuel Equipment Corp.
Uehling Instrument Co.

Engineers, Construction
Austin Co., The
Chemical Construction Co.
Deverell, Spencer & Co.
Green Co., Samuel M.
Guarantee Construction Co.
Thompson Starrett Co.

Engineers, Filtration
Filtration Engineers, Inc.

Engineers, Furnace
Booth Electric Furnace Co.
Hagan, Geo. J., Co.
Rockwell, W. S., Co.

Engines, Steam and Hauling
Vulcan Iron Works

Evaporating Dishes
Acid Proof Clay Products Co.
Guernsey Earthenware Co.
Knight, Maurice A.
Mine & Smelter Supply Co., The
Thermal Syndicate, Ltd., The

Evaporators
Badger, E. B., & Sons Co.
Blair, Campbell & McLean, Inc.
Blaw-Knox Co.
Buffalo Foundry & Machine Co.
Devine, J. P., Co.
Garrigue & Co., Wm.
International Oxygen Co.
Jacoby, Henry E.
Kestner Evaporator Co.
Koven, L. O., & Bro.
Lancaster Iron Works, Inc.
Lummus, The Walter E., Co.
Oakland Copper & Brass Works
Ott, Geo. F., Co.
Pfaudler Co., The
Pratt Eng. & Machine Co.
Sperry, D. R., & Co.
Stokes Machine Co., F. J.
Swenson Evaporator Co.
Wheeler Condensor & Engrg. Co.
Zaremba Co.

Exhausters
Roots, P. H. F. M., Co.
Schutte & Koerting Co.

Extractors
Badger, E. B., & Sons Co.
Blair, Campbell & McLean, Inc.
Buffalo Foundry & Machine Co.
Devine, J. P., Co.
Koven, L. O., & Bros.
Lummus, The Walter E., Co.

Extractors, Centrifugal
Fletcher Works
Gillespie Motor Co.
Tolhurst Machine Works

Fans
Buffalo Forge Co.
Buffalo Steam Pump Co.,
General Electric Co.
Philadelphia Drying Machy. Co.
Philadelphia Textile Mach. Co.
Pratt Eng. & Machine Co.
Raymond Bros. Impt. Pulv. Co.
Schutte & Koerting Co.
Vulcan Iron Works

Fans, Stoneware, Acid Proof
General Ceramics Co.
Knight, Maurice A.
U. S. Stoneware Co.

Faucets, Stoneware, Acid Proof
See Stoneware, Chemical

Feeders
American Pulverizer Co.
Bartlett & Snow, The C. O., Co.
Jeffrey Manufacturing Co., The
Webster Mfg. Co.

Felts, Paper Makers
Albany Felt Co.

Fences, Chain Link
Anchor Post Iron Works

Fences, Iron and Wire
Anchor Post Iron Works

Fences, Unclimbable Factory
Anchor Post Iron Works

Ferro-Alloys
Metal & Thermit Corp.
Titanium Alloy Mfg. Co., The

Ferro-Carbon-Titanium
See Titanium

Filing Cabinets
Kewaunee Mfg. Co.
Schwartz Sectional System

Filter Cloth
Albany Felt Co.
Mount Vernon Woodberry Mills, Inc.
Pendleton Woolen Mills
Turner-Halsey Co.

Filter Cloth, Metallic
Ludlow-Saylor Wire Co.
Multi-Metal Co., Inc.
Newark Wire Cloth Co.
Tyler, The W. S., Company
United Filters Corp.

Filter Paper
Angel, H. Reeve & Co.
Eimer & Amend

Filter, Porous Porcelain
Herold China & Pottery Co.

Filter Presses
Abbé Engineering Co.
American Continuous Filter Co.
Bay City Iron Co.
Colorado Iron Works Co.
Industrial Filtration Corp.
Johnson Co., John
Kelly Filter Press Co.
Koven, L. O., & Bro.
Lungwitz, Emil E.
Merrill Co., The
Oliver Continuous Filter Co.
Patterson Foundry & Machine Co.
Shriver, T., & Co.
Sperry, D. R., & Co.
Sweetland Filter Press Co.
United Filters Corp.

Filtering Media
Celite Products Co.
Norton Co.

Filters
Permutit Co.

Filters, Air
Dust Recovering & Conveying Co.

Filters, Dust
Dust Recovering & Conveying Co.

Filters, Oil
Permutit Co.

Filters, Rotary Continuous
American Continuous Filter Co.
Colorado Iron Works Co.
General Filtration Co.
Industrial Filtration Co.
Kelley Filter Press Co.
Oliver Continuous Filter Co.
Sweetland Filter Press Co.
United Filters Corp.

Filters, Suction, Stoneware Acid Proof
General Ceramics Co.
General Filtration Co.
Knight, Maurice A.
U. S. Stoneware Co.

Filters, Water
Hungerford & Terry
Permutit Co.
Scaife & Sons Co., Wm. B.
Stevens-Aylsworth Co.

Fire Extinguishers
American La France Fire Engine Co.

Flooring
Irving Iron Works Co.

Floor Grating
Irving Iron Works Co.

Flooring, Metallic
Irving Iron Works Co.

Flooring, Non-Slipping
Irving Iron Works Co.

Floors and Pits, Acid Resisting
Anti-Hydro Waterproofing Co.

Flotation Apparatus
Braun Corp., The
Braun-Knecht-Heimann Co.
Colorado Iron Works
Mine & Smelter Supply Co., The

Forgings
International Nickel Co., The

Furnaces, Caustic Pot
Frank H. Nickle

Furnace Doors, Chain
Codd Co., E. J.

Furnace Facings and Linings
Acheson Graphite Co.
Celite Products Co.
Crescent Refractories Co.
Dixon, Jos., Crucible Co.
Quigley Furnace Specialties Co.

Furnace Hoists
Brown Hoisting Machinery Co.

Furnace Insulating
Celite Products Co.

Furnaces, Assay
Braun Corp., The
Braun-Knecht-Heimann Co.
Denver Fire Clay Co., The

Furnaces, Brass or Aluminum Melting
Booth Electric Furnace Co.
Detroit Electric Furnace Co.
Pittsburgh Furnace Co.

Furnaces, Cupola Foundry
Worthington Pump & Mchy. Corp.

Furnaces, Electric
Booth Electric Furnace Co.
Detroit Electric Furnace Co.
Hamilton & Hansell, Inc.
Leavitt, C. W., & Co.
Pittsburgh Furnace Co.

Furnaces, Electric, Lab'y
Brown Instrument Co.
Central Scientific Co.
Eimer & Amend
Electric Htg. Apparatus Co.
Engelhard, Chas.
Hoskins Mfg. Co.
Mine & Smelter Supply Co., The

Furnaces, Heat Treating
Brown-Instrument Co.
Electric Htg. Apparatus Co.
Engelhard, Chas.
Hagan, Geo. J., Co.
Hoskins Mfg. Co.
Mine & Smelter Supply Co., The
Rockwell, W. S., Co.

Furnaces, Melting
Oil, Gas or Powdered Coal
Hagan, Geo. J., Co.

Furnaces, Muffle
Electric Htg. Apparatus Co.
Hoskins Mfg. Co.
Improved Equipment Co.
Mine & Smelter Supply Co., The

Furnaces, Roasting and Smelting
Allis-Chalmers Mfg. Co.
Colorado Iron Works Co.
General Chemical Co.
Mine & Smelter Supply Co., The
Wedge Mechanical Furnace Co.
Worthington Pump & Machinery Corp.

Furnaces, Sulphur
General Chemical Co.
Pratt Eng. & Machine Co.

Fused Silica
Thermal Syndicate, Ltd., The

Gas Machines
Detroit Heating & Lighting Co.
Tirrill Gas Machine & Lighting Co.

Gas, High Pressure
International Oxygen Co.

Gas Producers
Chapman Engineering Co.
Flinn & Dreffein Co.
Hagan, Geo. J., Co.
Improved Equipment Co.
Morgan Construction Co.
Smith Gas Engineering Co., The
Steere Eng. Co.
Wellman-Seaver-Morgan Co.

Gas Scrubbers and Washers
Bartlett Hayward Co.
Buffalo Forge Co.
Buffalo Steam Pump Co.

Gaskets
Sarco Co., Inc.

Gates, Iron and Wire
Anchor Post Iron Works

Gauges, Recording, Indicating, Draft, Pressure
Bailey Meter Co.
Bristol Co., The
Brown Instrument Co.
Cleveland Instrument Co.
Foxboro Co., The
Schaeffer & Budenberg Mfg. Co.
Taylor Instrument Cos.
Thwing Instrument Co.
Uehling Instrument Co.
Widney Co., The

Gears
Caldwell, H. W., & Son Co.

Gears, Reduction
Jones Foundry & Mach. Co., W. A.

Gears, Silent
General Electric Co.

Generators
See Dynamos and Motor

Generators (Oxygen and Hydrogen)
Electrolabs, Inc.

Glass Blowing
Eimer & Amend
International Glass Co.
Lenz Apparatus Co.
Scientific Utilities Co.

Glassware, Chemical
Flasks, Beakers, Crystallising Dishes, Hydrometer Jars, Petri Dishes, etc.
Central Scientific Co.
Durand-Koering Glass Co., Inc.
Eimer & Amend
Griebel Instrument Co.
International Glass Co.
Scientific Materials Co.
Scientific Utilities Co.
Will Corporation, The

Graphite
Acheson Graphite Co.

Grating, Subway
Irving Iron Works Co.

Grinders
See Machinery, Crushing, Grinding and Pulverizing

Grinding Wheels
Norton Co.

Gutters
Robertson Co., H. H.

Guy, Stiff Leg, Steel
Insley Manufacturing Co.

Gypsum Roofs
Robertson Co., H. H.

Heat Insulation
Celite Products Co.

Heaters, Feed Water
Atmospheric Conditioning Corp.

Heating Apparatus and Systems
American Blower Co.
Atmospheric Conditioning Corp.
Buffalo Steam Pump Co.
Buffalo Forge Co.
Fleisher, W. L., & Co., Inc.
Parks-Cramer Co.
Powers Regulator Co., The
Ruggles-Coles Eng. Co.
Sarco Co., Inc.

Heating Regulators
Powers Regulator Co., The

Hoists
Fairbanks, Morse & Co.

Hoods, Fume
Robertson Co., H. H.

Hydro Carbons, Technical
Robertson Co., H. H.

Hydrometers
Brown Instrument Co.
Griebel Instrument Co.
International Glass Co.

Hydrogen Generating Apparatus
Electrolabs, Inc.

Hydrogen Plants
Electrolabs, Inc.
Improved Equipment Co.

Ilmenite
American Rutile Co.

Instruments, Electrical and Testing
Bristol Co., The
Cleveland Instrument Co.
Eimer & Amend
General Electric Co.
Hoskins Mfg. Co.
Precision Them. & Inst. Co.
Pyrolectric Instrument Co.
Schaeffer & Budenberg Mfg. Co.
Shore Instrument Co.
Stupakoff Laboratories
Thwing Instrument Co.
Uehling Instrument Co.
Valley Iron Works (W'msport, Pa.)
Westinghouse Electric & Mfg. Co.
Widney Co., The
Wilson-Maulen Co.

Insulating Material, Electric
Redmanol Chemical Products Co.

Insulating Material, Heat
Armstrong Cork & Insulating Co.
Magnesia Assn. of America, The
Robertson Co., H. H.

Jackets, Paper Makers
Albany Felt Co.

Jigs
Worthington Pump & Mach. Corp.

Kettles, Cast Iron, Acid Proof
Bethlehem Foundry & Mach. Co.
Buffalo Foundry & Machine Co.
Devine, J. P., Co.
Duriron Castings Co.
Stevens-Aylsworth Company.
U. S. Cast Iron Pipe & Fdy. Co.
Valley Iron Works (Williamsport, Pa.)

Kettles, Enameled, Acid Proof
Elyria Enameled Products Co.
Glass Coating Co.
Pfaudler Co.

Kettles, Steam-Jacketed
Buffalo Fdy. & Machine Co.
Day, J. H., Company
Detroit Heating & Lighting Co.
Devine Co., J. P.
Duriron Castings Co.
Glass Coating Co.
Lummus, The Walter E., Co.
Pfaudler Company, The
Pratt Eng. & Machine Co.
Sowers Mfg. Co.
Stevens-Aylsworth Company.
Stuart & Peterson Co.

Kettles, Stoneware, Acid Proof
See Stoneware, Chemical

Kiln, Lime
Crescent Refractories Co.
Vulcan Iron Works

Kiln, Rotary and Nodulizing
American Process Co.
Ruggles-Coles Eng. Co.
Vulcan Iron Works

Laboratory Apparatus and Supplies
Braun Corp., The
Braun-Knecht-Heimann Co.
Buffalo Dental Mfg. Co.
Daigger, A., & Co.
Detroit Heating & Lighting Co.
Eimer & Amend
Gaertner, Wm., & Co.
Griebel Instrument Co.
Guerneay Earthenware Co.
Hoskins Mfg. Co.
International Glass Co.
Lenz Apparatus Co.
Norton Company
Pyrolectric Instrument Co.
Sargent, E. H., & Co.
Schaar & Co.
Scientific Materials Co.
Scientific Utilities Co.
Tirrill Gas Machine & Lighting Co.
Widney Co., The
Will Corporation, The

Laboratory Furniture
Kewaunee Mfg. Co.
Schwartz Sectional System

Lamps, Arc and Incandescent
General Electric Co.

Leaded Zinc Oxide
New Jersey Zinc Co., The

Lifts, Air Jet
Bethlehem Fdy. & Mach. Co.
Lummus, The Walter E., Co.
Monarch Mfg. Works, Inc.

Lithopone
New Jersey Zinc Co., The

Lime, Chemical
Mitchell Lime Co.

Lime, Hydrated
Mitchell Lime Co.

Linings for Barrels and Bags
Arkell Safety Bag Co.

Loaders, Bucket
Barber-Greene Co.

Loaders, Pneumatic
Dust Recovering & Conveying Co.

Loaders, Wagon & Truck
Gifford-Wood Co.

Locomotives, Gasoline
Fate-Root-Heath Co.

Locomotives, Industrial
Fate-Root-Heath Co.
General Electric Co.
Jeffrey Manufacturing Co., The
Vulcan Iron Works

Machinery, Agitating
Buffalo Fdy. & Machine Co.
Caldwell, W. E., Co.
Day, J. H., Company
Dorr Co., The
Gedge-Gray Co., The
Johnson Company, John
New England Tank & Tower Co.
Nickle, Frank H.
Sowers Mfg. Co.

Machinery, Automatic Weighing
Schaffer Eng. & Equip. Co.

Machinery, Classifying
Dorr Co., The

Machinery, Coal Grinding
Aero Pulverizing Co.
American Pulverizer Co.
Jeffrey Manufacturing Co., The
Pratt Eng. & Machine Co.
Raymond Bros. Impt. Pulv. Co.
Williams Patent Crusher & Pulv. Co.

Machinery, Conveying and Elevating
Caldwell, H. W., & Son Co.
Dust Recovering & Conveying Co.
Gifford-Wood Co.
Jeffrey Manufacturing Co., The
Link-Belt Company
Robins Conveying Belt Co.
Stephens-Adamson Mfg. Co.
Valley Iron Works (Williamsport, Pa.)
Webster Mfg. Co.
Wellman-Seaver-Morgan Co.

Machinery, Crushing, Grinding and Pulverizing
Abbe Engineering Co.
Aero Pulverizer Co.
American Pulverizer Co.
Bacon, E. C.
Buchanan, C. G., & Co.
Colorado Iron Works Co.
Day, J. H., Company
Fuller-Lehigh Co.
Jeffrey Manufacturing Co., The
Kent Mill Co.
Patterson Foundry & Machine Co.
Pratt Eng. & Machine Co.
Raymond Bros. Imp. Pulv. Co.
Standard Mechanical Equip. Co.
Sturtevant Mill Co.
Vulcan Iron Works
Williams Patent Crusher & Pulv. Co.
Worthington Pump & Machinery Corp.

Machinery, Crushing, Grinding and Pulverizing, Laboratory
Abbé Engineering Co.
Aero Pulverizer Co.
Braun Corp., The
Braun-Knecht-Heimann Co.
Jeffrey Manufacturing Co., The
Sturtevant Mill Co.
Worthington Pump & Machinery Corp.

Machinery, Cyanide
Allis-Chalmers Mfg. Co.
Colorado Iron Works Co.
Dorr Co., The
Worthington Pump & Machinery Corp.

Machinery, Dyeing
Philadelphia Drying Mach'y Co.

Machinery, Metallurgical and Mining
Abbé Engineering Co.
Aero Pulverizer Co.
American Continuous Filter Co.
American Process Co.
Colonial Supply Co.
Colorado Iron Works Co.
Dorr Co., The
Fuller-Lehigh Co.
General Chemical Co.
Huff Electrostatic Separator Co.
Kelly Filter Press Co.
Kent Mill Co.
Lungwitz, Emil E.
Raymond Bros., Imp. Pulv. Co.
Ruggles-Coles Eng. Co.
Sturtevant Mill Co.
Sweetland Filter Press Co.
Tyler, The W. S., Company
United Filters Corp.
Vulcan Iron Works Co.
Worthington Pump & Machinery Corp.

Machinery, Mixing and Kneading
Abbé Engineering Co.
Buffalo Foundry & Machine Co.
Day, J. H., Company
Gedge-Gray Co., The
New England Tank & Tower Co.
Patterson Foundry & Machine Co.
Pratt Eng. & Mfg. Co.
Sowers Mfg. Co.

Machinery, Ore Concentrating
Dorr Co., The
Kent Mill Co.
Ruggles-Coles Eng. Co.
Worthington Pump & Machinery Corp.

Machinery, Ore and Coal Handling
Barber-Greene Co.
Gifford-Wood Co.
Jeffrey Manufacturing Co., The
Link-Belt Co.
Stephens-Adamson Mfg. Co.
Webster Mfg. Co.

Machinery, Paper Making
Noble & Wood Machine Co.

Machinery, Pipe Bending
American Pipe Bending Machine Co.

Machinery, Refrigerating
Vogt, Henry, Machine Co.
York Manufacturing Co.

Machinery, Screening
Gifford-Wood Co.
Jeffrey Manufacturing Co., The
Stephens-Adamson Mfg. Co.
Tyler, The W. S., Company
Webster Mfg. Company
Worthington Pump & Machinery Corp.

Machinery, Special
Buffalo Foundry & Machine Co.
Day, J. H., Company
Phoenix Iron Works Co.
Stevens-Aylsworth Company

Machinery, Thickening and Dewatering
Buffalo Fdry. & Machine Co.
Dorr Co., The

Machinery, Transmission
Caldwell, H. W., & Son Co.
Jeffrey Manufacturing Co., The
Stephens-Adamson Mfg. Co.
Webster Mfg. Co.

Machinery, Turbine
De Laval Steam Turbine Co.

Machinery, Weighing
Schaeffer Eng. & Equip. Co.
Sturtevant Mill Co.

Magnesium Metal
Leavitt, C. W., & Co.
Norton Laboratories, Inc.

Magnesium Ribbon
Daigger, A., & Co.

Magnetic Pulleys
Dings Magnetic Separator Co.
Magnetic Mfg. Co.

Magnetic Separators
Buchanan, C. G., Co., Inc.
Dings Magnetic Separator Co.
Magnetic Mfg. Co.

Magnets
Dings Magnetic Separator Co.
Magnetic Mfg. Co.

Metallurgical Engineers
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Metal, Protected
Robertson Co., H. H.

Metals and Alloys
Metals Disintegrating Co.
Metal & Thermit Corp.

Meter Box Covers
Cast Iron Pipe Publicity Bureau

Meters, Electrical Measuring
Weston Electrical Instrument Co.

Meters, Flow, Air, Gas, Water
Bailey Meter Co.
General Electric Co.
Spray Engineering Co.

Microscopes
Scientific Materials Co.

Mills, Ball, Pebble and Tube
Abbe Engineering Co.
International Nickel Co., The
Patterson Foundry & Machine Co.
Worthington Pump & Machinery Corp.

Mills, Emery
Sturtevant Mill Co.

Minerals and Ores
Leavitt, C. W., & Co.

Mixers, Batch
Gedge-Gray Co.

Monel Metal
International Nickel Co., The
Multi-Metal Co., Inc.

Motor Buffing & Polishing
Eager Electric Co.

Motors, Electric
Fairbanks, Morse & Co.
General Electric Co.
Westinghouse Electric Mfg. Co.

Nitric Acid Plants
Buffalo Foundry & Machine Co.

Nozzles, Spray
American Blower Co.
Buffalo Forge Co.
Buffalo Steam Pump Co.
Carrier Eng. Corp.
Duriron Castings Co.
Monarch Mfg. Works, Inc.
Schutte & Koerting Co.
Spray Engineering Co.

Ores
See Minerals and Ores

Ore Bedding and Reclaiming Systems
Robins Conveying Belt Co.
Stephens-Adamson Manufacturing Co.

Ovens, Laboratory
Thermo Electric Instrument Co.

Oxygen and Hydrogen Generating Equipment
Electrolabs, Inc.

Paint Pigment, Graphite
Acheson Graphite Co.

Paints, Acid Proof and Technical
Toch Bros.
Robertson Co., H. H.

Palau Ware
Braun Corp.
Braun-Knecht-Heimann Co.

Pans, Vacuum
Badger, E. B., & Sons Co.
Blair, Campbell & McLean, Inc.
Buffalo Foundry & Machine Co.
Devine Co., J. P.
Kestner Evaporator Co.
Lummus, The Walter E., Co.
Pfaudler Co., The
Sowers Mfg. Co.
Swenson Evaporator Co.
Wheeler Condenser & Engrg. Co.
Zaremba Co.

Paper, Elastic
Arkell Safety Bag Co.

Patent Attorneys
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Pipe, Cast Iron
Cast Iron Pipe Publicity Bureau
Glamorgan Pipe & Foundry Co.
U. S. Cast Iron Pipe & Fdy. Co.

Pipe, Silica Ware
Thermal Syndicate, Ltd., The

Pipe and Filters, Cast Iron Acid Proof
Crane Co.
Duriron Castings Co.
Glass Coating Co.
Pfaudler Co., The
Stuart & Peterson Co.

Pipe and Fittings, Copper
Badger, E. B., & Sons Co.
Lummus, The W. E. Co.
Ott, Geo. F., Co.
Whitlock Coil Pipe Co.

Pipe and Fittings, Lead, Tin or Silver Lined
Badger, E. B., & Sons Co.
Cleveland Brass Mfg. Co., The
United Lined Tube & Valve Co.

Pipe and Fittings, Stoneware, Acid Proof
Acid Proof Clay Products Co.
General Ceramics Co.
Knight, Maurice A.
U. S. Stoneware Co.

Pipe and Fittings, Wood
Michigan Pipe Co.
National Tank & Pipe Co.
Pacific Tank & Pipe Co.

Pipe Covering Wood
Michigan Pipe Co.

Platinum Wire, Sheet and Foil, Crucibles, Dishes, Electrodes, Laboratory Ware, all kinds
American Platinum Works
Baker & Co., Inc.
Bishop, J., & Co., Plat. Wks.

Pneumatic Tools
Ingersoll-Rand Company

Porcelain Ware
Guernsey Earthenware Co.
Herold China & Pottery Co.

Pots, Cast Iron, Acid Proof
Bethlehem Foundry & Mach. Co.
Buffalo Foundry & Machine Co.
Duriron Castings Co.
U. S. Cast Iron Pipe & Fdy. Co.
Valley Mould & Iron Works

Pots and Pans, Steel
Janney-Steinmetz Co.

Pots, Stoneware, Acid Proof
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Powdered Coal Equipment
Aero Pulverizer Co.
American Industrial Eng. Co.
Pulverized Fuel Equipment Co.
Raymond Bros. Imp. Pul. Co.
Standard Mechanical Equip. Co.

Power
Tennessee Power Co.

Precipitation Processes
Merrill Co., The

Precipitators, Centrifugal
Fletcher Works

Protected Metal
Robertson Co., H. H.

Pulleys, Magnetic
Dings Magnetic Separator Co.

Pulverizers, Ring Hammer Mills
American Pulverizer Co.

Pumps, Acid or Acid Gases
Abbé Engineering Co.
American Well Works, Ltd.
Beach-Russ Co.
Duriron Castings Co.
Elmore, G. H.
Goulds Mfg. Co.
Lea-Courtenay Co.
Lummus, The Walter E., Co.
Nash Engineering Co., The
Nassau Valve & Pump Corp.
Rumsey Pump Co.
United Lined Tube & Valve Co.
Worthington Pump & Machinery Corp.

Pumps, Centrifugal
Abbé Engineering Co.
Buffalo Steam Pump Co.
Duriron Castings Co.
Goulds Mfg. Co.
Ingersoll-Rand Company
Lea-Courtenay Co.
Schutte & Koerting Co.
Taber Pump Co.
Worthington Pump & Machinery Corp.

Pumps, Diaphragm
Goulds Mfg. Co.
Johnson Company, John

Pumps, Fire
Lea-Courtenay Co.

Pumps, Gas, Liq., or Vacuum
Beach-Russ Co.
Buffalo Foundry & Machine Co.
Crowell Mfg. Co.
Devine, J. P., Co.
Fairbanks, Morse & Co.
Goulds Mfg. Co.
Ingersoll-Rand Company
Nash Engineering Co.

Pump Lines
International Nickel Co., The

Pumps, Brine
Lea-Courtenay Co.

Pumps, Mine
Lea-Courtenay Co.

Pumps, Piston
Ingersoll-Rand Company

Pumps, Rotary, Oil or Water
Goulds Mfg. Co.
Rumsey Pump Co., Ltd.
Taber Pump Co.

Pumps, Sand
Krogh Pump Mfg. Co.

Pumps, Stoneware, Acid Proof
General Ceramics Co.
Knight, Maurice A.
U. S. Stoneware Co.

Pumps, Triplex
Goulds Mfg. Co.

Pumps, Vacuum
Buffalo Foundry & Machine Co.

Pyrometers
Bristol Co., The
Brown Instrument Co.
Engelhard, Chas.
Hoskins Mfg. Co.
Pyrolectric Instrument Co.
Sargent, E. H., & Co.
Shaeffer & Budenberg Mfg. Co.
Shore Instrument Co.
Stupakoff Laboratories
Taylor Instrument Co.
Thwing Instrument Co.
Wilson-Maulen Co.
Uehling Instrument Co.

Pyrometer Protection Tubes
Engelhard, Charles
Herold China & Pottery Co.
Stupakoff Laboratories, The
Thermal Syndicate, Ltd., The

Pyrometer Sheets, Graphite
Acheson Graphite Co.

Pyroscopes
Shore Instrument Co.

Railways, Iron
Anchor Post Iron Works

Railways, Industrial and Portable
Easton Car & Const. Co.

Reagent Cabinets
Kewaunee Mfg. Co.
Schwartz Sectional System

Recorders CO-2
Uehling Instrument Co.

Recording Instruments, Pressure Temperature, Electricity, Motion, Speed, Time
Bristol Co., The
Foxboro Co., The
Precision Therm. & Inst. Co.
Pyrolectric Instrument Co.
Schaeffer & Budenberg Mfg. Co.
Thwing Instrument Co.
Uehling Instrument Co.
Wilson-Maulen Co.
Widney Co. The

Regulators, Automatic Humidity
Carrier Engineering Corporation

Regulators, Pressure and Temperature
Bailey Meter Co.
Crane Co.
Foxboro Co., The
Lummus, The Walter E., Co.
Powers Regulator Co., The
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Respirators
American La France Fire Engine Co.
Multi-Metal Co., Inc.

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Retorts, Graphite
Bartley, Jonathan, Crucible Co.

Retorts, Vertical
Buffalo Foundry & Machine Co.
Isbell-Porter Co.

Rolls, Crushing
American Pulverizer Co.
Buchanan, C. G., Co., Inc.
Jeffrey Manufacturing Co., The

Roofing
Robertson Co., H. H.

Rutile
American Rutile Co.

Safety Devices
American La France Fire Engine Co.

Safety Goggles
American La France Fire Engine Co.

Sample Cabinets
Schwartz Sectional System

Saturation Compounds
Robertson Co., H. H.

Scales, Conveyor
Schaeffer Eng. & Equip. Co.

Scales, Weighing
Fairbanks, Morse & Co.
Sturtevant Mill Co.

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Newark Wire Cloth Co.
Patterson Foundry & Machine Co.
Stephens-Adamson Manufacturing Co.
Sturtevant Mill Co.

Screens, Mining
Ludlow-Saylor Wire Co., The

Screens, or Cloth, Fertilizer
Ludlow-Saylor Wire Co., The

Screens, Wire, Brass, Copper, Steel, etc.
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Tyler, The W. S., Company

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Consolidated Products Co.
Glander & Co.
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Magnolia Metal Co.
Miller, I.

Morse Bros. Mach. & Supply Co.
Ogden Laboratories
Ohio Smelting and Refining Co.
Perry, Buxton, Doane Co.
Standard Elec. & Elev. Co.
Stewart, Paul & Co.
Technical Products Co.
Wickes Mach. Co.
Zelnicker, Walter A., Supply Co

Sheeting, Metal
Robertson Co., H. H.

Skylights
Robertson Co., H. H.

Separators, Centrifugal
Fletcher Works
Tolhurst Mach. Works

Separators, Electrostatic
Huff Electrostatic Separator Co.

Separators, Inclined Vibrating Screen
Sturtevant Mill Co.
Tyler, The W. S., Company

Separators, Magnetic
Ding's Magnetic Separator Co.
Magnetic Mfg. Co.

Separators, Steam and Oil
Atmospheric Condition Corp.

Separators, Air
Raymond Bros. Imp. Pulv. Co.
Standard Mechanical Equip. Co.

Siding
Robertson Co., H. H.

Sieves, Laboratory
Multi-Metal Co., Inc.
Newark Wire Cloth Co.

Slime Filters
Merrill Co., The

Solvent Recovery Apparatus
Lummus, The Walter E., Co.

Specimen Cabinets
Schwartz Section System

Spelter Spiegeleisen
New Jersey Zinc Co., The

Sprockets
Fuller-Lehigh Co.

Steel, High Speed
Standard Alloys Co.

Steel Plate Construction
Chicago Bridge & Iron Works
Sharpsville Boiler Works
Standard Tank Car Co.

Steel Sheets for Roofing & Siding
Robertson Co., H. H.

Steel, Structural
Insley Manufacturing Co.

Steel Sheets, Protected
Robertson Co., H. H.

Sterilizers, Ultra Violet Ray
R. U. V. Company, Inc., The

Stirrers, Acid Proof
Acheson Graphite Co.
Duriron Castings Co.

Stokers
American Engineering Co.
Hagan, Geo. J., Co.
Laclede-Christy Co.

Stoneware, Chemical, consisting of:
Bottles, Carboy Stoppers, Coils and Worms, Crystalizing Dishes, Chlorine, Generators, Decanting Pots, Dippers, Dipping Dishes, Faucets, Funnels, Kettles, Mortars and Pestles, Nozzles and Jets, Pots and Jars, Pitchers, Retorts, Receivers or Woulff Bottles, Sinks, Storage Jars, etc.
Acid Proof Clay Products Co.
Dorchester Pottery Works
General Ceramics Co.
Knight, Maurice A.
U. S. Stoneware Co.

Stopper Heads
Bartley, Jonathan, Crucible Co.

Sulphur
Texas Gulf Sulphur Co.

Sulphur, Crude
Texas Gulf Sulphur Co.
Union Sulphur Co., The

Sulphuric Acid Plants
Buffalo Foundry & Machine Co.
Chemical Const. Co.

Supplies, Mill and Mine
Colonial Supply Co.

Switchboards
General Electric Co.
Westinghouse Electric & Mfg. Co.

Syphons, Acid, Stoneware
Knight, Maurice A.

Tachometers
Schaeffer & Budenberg Mfg. Co.

Tank Cars
General American Tank Car Corp.
Standard Tank Car Co.

Tanks, Acid
Sharpsville Boiler Works
Lancaster Iron Works, Inc.

Tanks, Cast Iron
Buffalo Foundry & Machine Co.
Detroit Range Boiler and Steel Barrel Co.

Tanks, Copper
Lummus Co., The Walt. E.

Tanks, Cyanide
Acme Tank Co.
Pacific Tank & Pipe Co.
Stearns Lumber Co., A. T.

Tanks, Enameled, Acid Proof
Glass Coating Co.
Stuart & Peterson Co.

Tanks, Jacketed
Lancaster Iron Works

Tanks, Lead Lined, Acid Proof
Acme Tank Co.
Blair, Campbell & McLean, Inc.
Chemical Construction Co.
Hauser-Stander Tank Co.
Johnson & Carlson
New England Tank & Tower Co.
Oakland Copper & Brass Works
Stearns Lumber Co., A. T.
United Line Tube & Valve Co.

Tanks, Oil
Lancaster Iron Works, Inc.
Sharpsville Boiler Works

Tanks, Pressure
Lancaster Iron Works, Inc.

Tanks, Steel
Caldwell, W. E., Co.
Chicago Bridge & Iron Works
Coatesville Boiler Works
Detroit Range Boiler and Steel Barrel Co.
Janney-Steinmetz Co.
Kellogg Co., The M. W.
Lancaster Iron Works
Manitowoc Engineering Works
Phoenix Iron Works Co.
Standard Tank Car Co.
Stevens Brothers

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General Ceramics Co.
Knight, Maurice A.

Tanks, Storage
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Tanks, Welded
Kellogg Co., The M. W.

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Atlantic Tank & Barrel Co.
Caldwell, W. E., Co.
Corcoran, Inc., A. J.
Hauser-Stander Tank Co.
Johnson & Carlson
Kalamazoo Tank & Silo Co.
National Tank & Pipe Co.
New England Tank & Tower Co.
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Rosenwach, J.
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Precision Therm. & Inst. Co.
Schaeffer & Budenberg Mfg. Co.
Taylor Instrument Co.

Thermostats
Sarco Company, Inc.

Thickeners (or Dewaterers)
General Engineering Co.

Titanium
General Engineering Co.
Titanium Alloy Mfg. Co.

Titanium Ores
Titanium Alloy Mfg. Co.

Tongs (Lifting)
Lummus, The Walter E., Co.

Tool Steel
Standard Alloys Co.

Tower Packing, Acid Proof Stoneware
Knight, Maurice A.

Towers, Acid
Duriron Castings Co.

Towers, Acid Proof Stoneware
Acid Proof Clay Products Co.
General Ceramics Co.
Knight, Maurice A.

Towers, Steel
Insley Manufacturing Co.
New England Tank & Tower Co.

Transformers
Allis-Chalmers Mfg. Co.
American Transformer Co.
General Electric Co.
Thordarson Electric Mfg. Co.
Westinghouse Electric & Mfg. Co.

Transformers, Special and Precipitation Process
American Transformer Co.

Transits
Ainsworth, Wm., & Son

Traps, Steam and Radiator
Sarco Company, Inc.

Tubes, Brass and Copper, Seamless Drawn
Wheeler Condenser & Engrg. Co.

Turbo Blowers
Ingersoll-Rand Company

Turntables, Industrial Railway
Easton Car & Const. Co.

Ultra Violet Ray Lamp
R. U. V. Company, Inc., The

Uranium Alloys
Standard Alloys Co.

Valves and Cocks
Jenkins Bros.
Merrill Co., The

Valves and Cocks, Metal, Acid-Proof
Chemical Equipment Co.
Cleveland Brass Mfg. Co.
Colonial Supply Co.
Crane Co.
Duriron Castings Co.
Johnson Co., John
Nassau Valve & Pump Corp.
Pratt Eng. & Machine Co.
Schutte & Koerting Co.
United Lined Tube & Valve Co.

Valves and Cocks, Stoneware, Acid-Proof
General Ceramics Co.
Knight, Maurice A.

Vanadium Alloys
Standard Alloys Co.

Vats, Metal, Acid-Proof
Duriron Castings Co.

Vats, Wood
Atlantic Tank & Barrel Co.
Hauser-Stander Tank Co.
Johnson & Carlson
New England Tank & Tower Co.
Pacific Tank & Pipe Co.
U. S. Wind Engine & Pump Co.
Wendnagel Co.

Ventilator or Car Cloth
Ludlow-Saylor Wire Co., The
Robertson Co., H. H.

Wagon Loaders
Barber-Greene Co.
Jeffrey Manufacturing Co., The
Link-Belt Company
Portable Machinery Co.

Washers, Cast Iron
Lummus, The Walter E., Co.

Washers, Chemical
Lummus, The Walter E., Co.

Waterproof Cements
Robertson Co., H. H.

Waterproofing Compound
Robertson Co., H. H.

Water Purifying Apparatus
Permutit Co.

Water Softeners
Hungerford & Terry, Inc.
Scaife & Sons, Wm. B.

Welding Materials
Acheson Graphite Co.
General Electric Co.
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National Carbon Co.

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Ludlow Saylor Wire Co.
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Newark Wire Cloth Co.
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Wires, Electrical
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Wood Distillation
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Zinc
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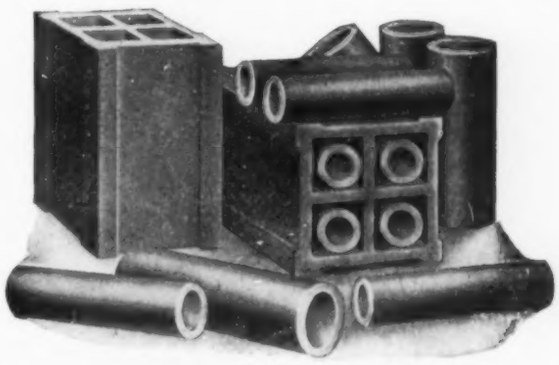
Vulcan Iron Works.	17
Warner Chemical Co., The.	63
Warren Fdry. & Mach. Co.	90
Wayte, W. J., Co.	126
Webster Mfg. Co.	84
Wedge Mechanical Furnace Co.	73
Wellman-Seaver-Morgan Co.	99
Wendnagel Co.	109
Werner & Pfleiderer.	65
Westinghouse Elec. & Mfg. Co.	50
Weston Elec. Instrument Co.	115
Wheeler Condenser & Eng. Mfg. Co.	81
Whitlock Coil Pipe Co.	87
Widney Co., The.	84
Will Corporation	114
Williams Apparatus Co.	123
Williams Pat. Crusher & Pulv. Co., Inc.	97
Wilson-Maeulen Co.	118
Zaremba Co.	5

Acid-Proof Tower Packing or Filling

We are now in a position to give

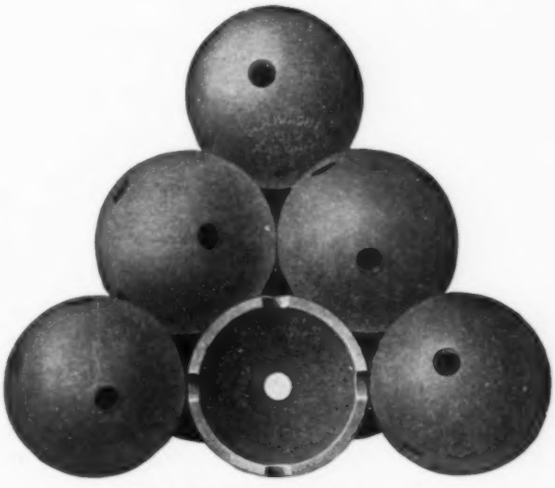
—Prompt Deliveries—

as we have quadrupled our capacity.



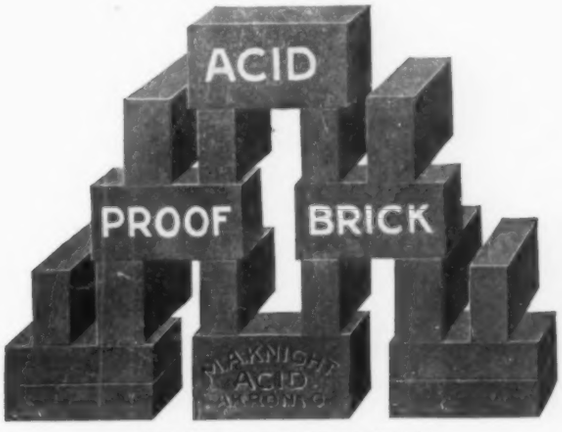
TOWER PACKING "A," "B," "C"

A strong and efficient packing for large Sulphuric Towers.
"A"—Partition block, 8 in. x 8 in. x 12 in.
"B"—4 in. x 12 in. Pipe—to break joints.
"C"—3 in. x 12 in. Pipe—to fill blocks, adding greatly to scrubbing surface.



ACID PROOF HOLLOW BALLS

The most efficient packing for small towers. Made 3½ in. in diameter. All our packing is salt glazed.

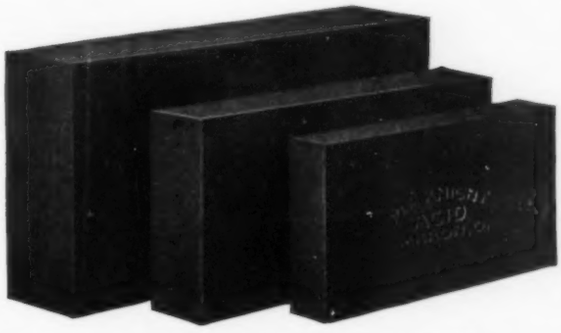


ACID PROOF VITRIFIED BRICK

Made in most any size or shape. Standard size 8 in. x 4 in. x 2 in. carried in stock. Used for packing or lining towers.

ACID PROOF PARTITION RINGS

The most popular tower packing for any kind or size tower. Note the curved partition. These rings afford a good draft and a maximum scrubbing surface. Made in three standard sizes—4 in. x 3 in., 4 in. x 6 in., 6 in. x 6 in.—carried in stock.



LARGE ACID PROOF TOWER BASETILE

Used for bridge work at bottom of towers for supporting packing. Made in any size up to 60 in. x 36 in. x 6 in.

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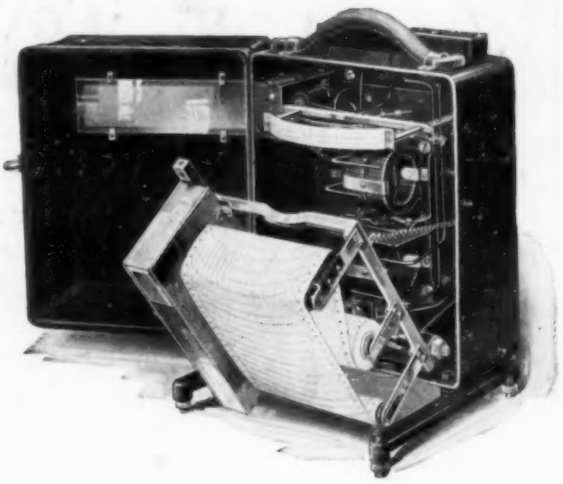

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